Content laboratory electrodes

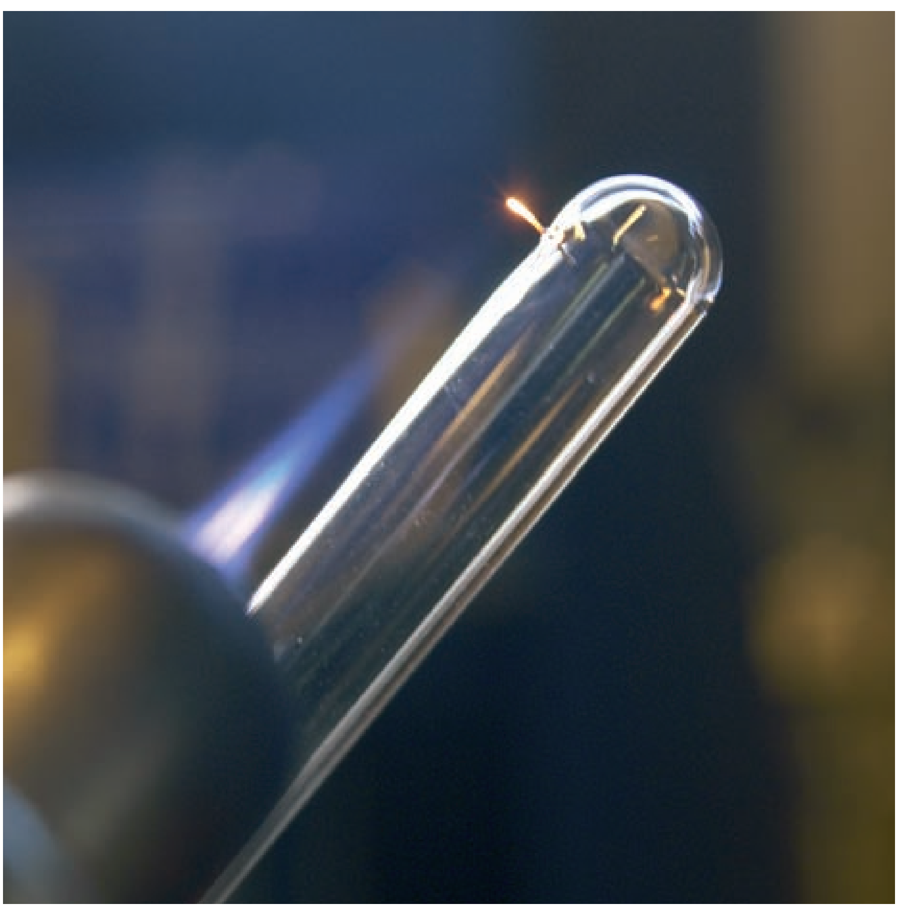
Our laboratory electrodes: application orientated and perfectly matched

The standards for pH measurement are very high regarding precision, reproducibility, speed, handling and reliability. Every measurement is different. Different compositions, temperatures, conductivities and viscosities of samples and different measured conditions make for a million of different applications. Only application orientated and perfectly matched systems of electrodes, meters and buffer solutions can meet these standards. At SI Analytics we supply such systems.

The pH electrode is a very important part of the system as it comes in direct contact with the sample and provides the measurement signal. For more than 75 years our focus has been set on the electrode and we have dedicated ourselves to the development and manufacturing of glass electrodes. For a long time our electrodes have been used for the most demanding tasks in labs throughout the world where quality matters, and our customers benefit from this expertise.

Our first instruction booklet appeared in 1938. In those days the electrochemical pH measuring and the potentiometric titration still needed to be explained.

It all started with a patent on pH electrodes – today it is a range of several hundred different sensors. Our electrode line includes three product families BlueLine, ScienceLine and IoLine to meet your applications. Whether for ultrapure water, jam, wine, creme or drinking water, SI Analytics offers the right electrode for every application.



Even today glass blowing talent is still indispensable.

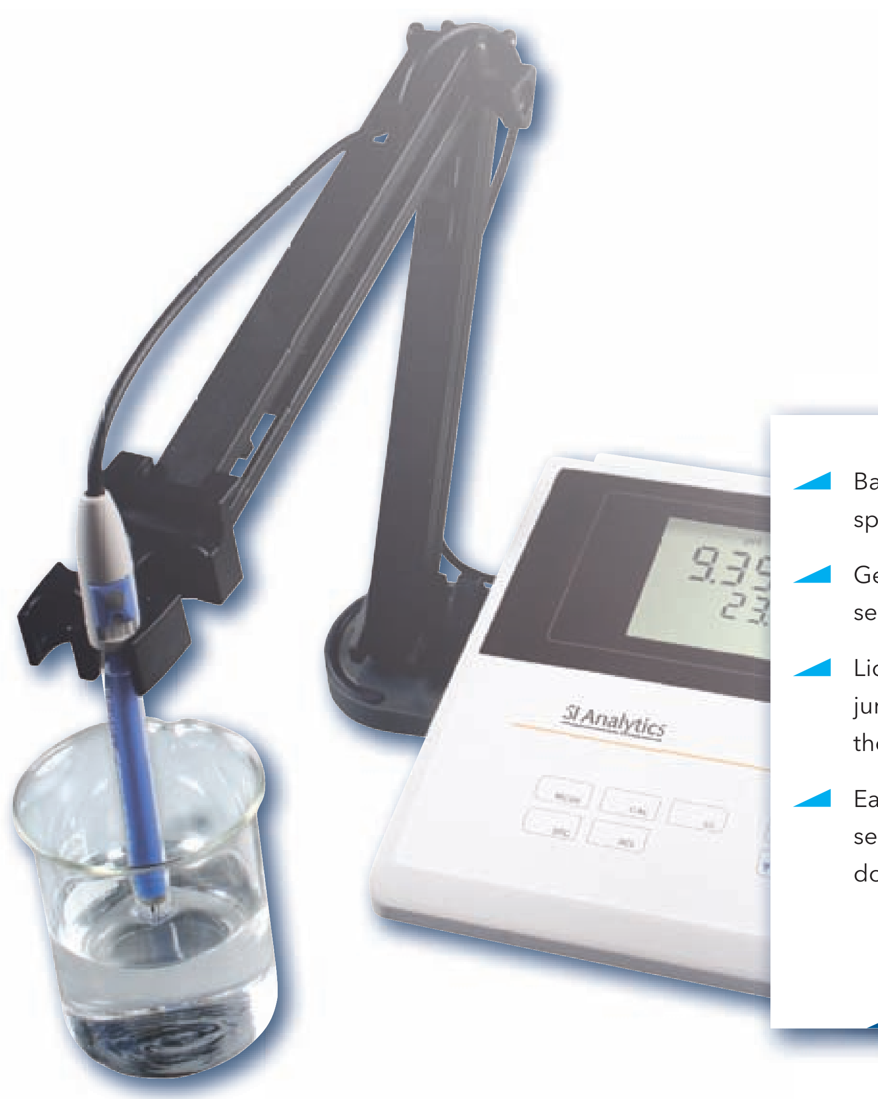
BlueLine Electrodes

Reliable function

Our compact BlueLine range is a basic series including electrodes for the typical laboratory applications which simplifies the user's choice.

An accurate and fast measurement is ensured by precision manufacturing and employment of high quality material, e.g. low-resistance A-type membrane glass or the unique platinum junction.

The BlueLine family includes robust electrodes with gel electrolyte and plastic shaft for general use, liquid-electrolyte sensors for more critical measurements and special sensors. The gel and the liquid electrolyte sensors are available with different connections and with different cable lengths. Some offer built-in temperature sensor. The special electrodes range includes pH electrode for surface measurements, for small sample amounts, for ultrapure water and emulsions or measurements in semi-solid samples (insert measurements).



- Basic series simplifies choice of the electrode for specific application
- Gel electrolyte, liquid electrolyte and special sensors with universal membrane glass
- Liquid electrolyte electrodes with unique platinum junction and refill port slider for easier refilling of the electrolyte
- Each electrode with individual serial number for clear documentation

Advantages BlueLine

ScienceLine Electrodes

The proven high-end laboratory electrodes

In research and development, manufacturing and quality control, our ScienceLine electrodes have become standard for the most demanding measurement tasks. Each electrode has an individual serial number and pH- and metal combination electrodes are supplied with a quality certificate, better making documentation simple and better traceable.

We have kept on improving the glass membrane shapes and types to make the electrodes even more robust, durable and easier to clean. Furthermore, they achieve stable measurement values even faster.

Our ScienceLine electrodes ensure high measurement accuracy and stability and long service life, but are highly adaptable to your measurement tasks. We can offer you a range of electrodes with unmatched versatility and quality.

Typical examples:

- pH electrodes with a length of up to 600 mm for measurements in very deep vessels
- The N 6003 electrode allows pH measurements even in NMR tubes or other small sample vessels. The A 157 is a micro electrode with an integrated temperature sensor with a 5 mm in diameter.
- For more demanding media, choose among different junctions and membrane glasses. For measurements in samples of low ionic strength there is a choice between the N 64 and A 164. Both types feature a ground joint junction, and the A 164 offers a temperature sensor.
- A wide selection of separate reference and glass electrodes completes the offering.

The more stable display of the measured value with Science Line electrodes, as well as their longer life are due to their Silamid reference system. In contrast to the silver/silver chloride reference system of the BlueLine series, the ScienceLine employs. The ScienceLine employs a double junction design where the inner tube is coated with silver which provides for a very stable electrode. Hence, the stability of the potential is much higher.

- Proven high-end electrodes for demanding measurement tasks
- Double junction Silamid® reference system for fast and stable acquiring of measured values and for longer electrode life.
- Utmost versatility of pH electrodes is achieved by a large selection of junctions, membrane glass types and shapes, shaft lengths and diameters, ground joints, plug connections and integrated temperature sensors.
- Each pH and metal combination electrode comes with individual serial number and quality certificate.
- Large selection of separate glass and reference electrodes, metal combination electrodes, conductivity sensors, ion selective electrodes and ammonia, sodium and oxygen sensors.

Advantages ScienceLine

IoLine pH electrodes for the most demanding measurement tasks

Patented three-chambers system with Iodine reservoir in the iodine/iodide reference electrode

The reference system is a very important part of the pH electrode. The standard hydrogen electrode has proven too difficult in practical use to gain more than a mere theoretical importance. The Ag/AgCl system, which is nowadays almost exclusively used, can cause measurement instabilities in contrast from potential variations with changing temperatures or reactions between the silver ions and the measuring solution in the area of the junction.

IoLine electrodes, in contrast, have the advantage of a much lower temperature sensitivity and a metal ion free reference system. The reference system is based on the following reaction:

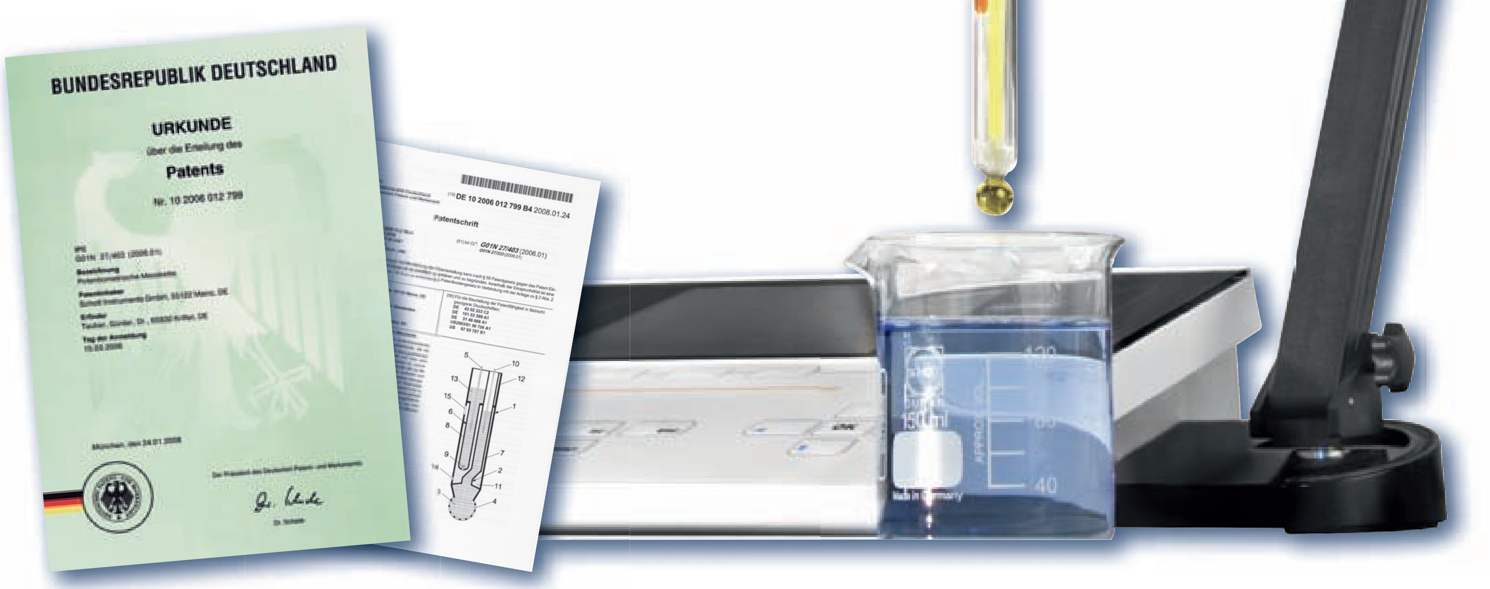
$I_2 + I^- + 2\,e^- \Leftrightarrow 3\,I^-$

The ORP is thereby described by the Nernstian equation:

$E = E° + RT/zF * \ln([I_3^-] / [I^-]^3)$

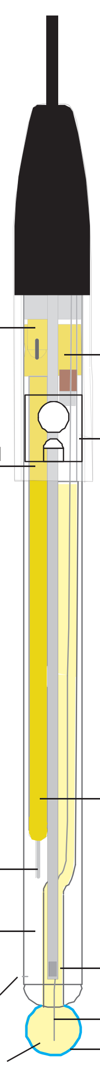
Whereby
$E° = 0.536$ V, $R = 8.314472$ J/(K*mol),
T in K, $z = 2$ und $F = 96,485.34$ C/mol.

The stability of the reference system potential even at changing temperatures is the key to the IoLine electrodes' superior response speed and measurement stability.



Platinum junction for fast response and high stability

Responsible for the high stability and fast response of the iodine/iodide reference system is our platinum junction, which has been developed by SCHOTT. It makes for remarkably constant and reproducible measurement characteristics of the electrode. The platinum junction contains twisted platinum wires being fused into the glass shaft of the electrode. The defined spaces of the platinum wires guarantee a continuous and steady electrolyte flow and high stability of the reference system in all media and at changing temperatures.



Unique iodine/iodide reference system
offers unbeatable stability, fast response times high accuracy and independence from sample composition and temperature compared to the electrodes with the usual Ag/AgCl reference system. Furthermore independent from sample composition and temperature.

Metal ion free reference system
avoids contamination of measurement media by unwanted metal ions i.e. optimal for use with Tris buffers. for measurements in Tris buffer.

Exchangeable bridge electrolyte
enables a matching of electrolyte solution and sample.

Wide application area
Ideal for most precise pH measurements in media for research and quality control i.e. pharmacy, biotechnology or food industry.

Electrode head with integrated refill port
enables easy refilling of the bridge electrolyte.

Extensive selection:
Many variants regarding the connection, the membrane glass types and shapes as well as junctions.

Delivered with:
Liquid vessel with bayonet connector to avoid drying of membrane and for storage of the electrode and certificate.

Advantages IoLine

The corresponding sensor for any application: Application recommendations for pH and ORP electrodes

The table provides an orientation to the large variety of our electrodes. The listed electrodes give an example for similar measuring models, i.e. variation only regarding the connection system or the integrated temperature sensor. The electrode BlueLine 11 pH for instance also represents the versions 12 pH, 14 pH, 15 pH, 17 pH, 18 pH and 19 pH. These models are also available with longer shaft lengths: ScienceLine and IoLine pH electrodes N 62 and H 62 as well as IL-pH-A120MF and IL-pH-H120MF. An extension of length under the same application conditions delivers faster and more stable measuring results; additionally it enables a longer life of the electrode. The higher electrolyte along with the increased electrolyte outflow reduces unwanted diffusion potentials on the junction and rinses it free.

Some applications may require other electrode recommendations due to certain conditions, as identical applications can differ fundamentally with varying concentrations and temperatures. Please also note the material resistance of the sensor towards the measuring media. The recommended and additional sensors with the corresponding technical data are stated on the following pages and the highlighted last section.

… and conductivity cells

Application area	Electrode series	pH measurement: IoLine		pH measurement							pH measurement: BlueLine			ORP: ScienceLine			ORP: BlueLine		Conductivity: ScienceLine			
	Sensor example / Application	IL-pH-A120MF	IL-pH-H120MF	A 7780	H 62	H 64	L 32	L 8280	N 62	N 64	11 pH	22 pH	13 pH	Ag 6280	Pt 62	Pt 8280	31 RX	32 RX	LF 313 T NFTC	LF 413 T	LF 613 T	LF 713 T
Chemistry	Etching and degreasing baths	■	■		■	■			■	■	■		■		■		■					■
	Bleach and dyeing solutions	■	■		■	■			■	■	■		■		■		■					■
	Cutting oil emulsions	■						■	■	■	■		■		■		■					■
	Cyanide detoxification	■	■		■	■			■	■	■		■		■		■					■
	Dispersion paint	■	■		■	■			■	■			■		■		■					■
	Emulsions, water-based	■	■		■	■		■	■	■	■		■		■		■		■			■
	Emulsions, partly water-based	■							■	■	■		■		■		■		■			■
	Paint/varnish, water-soluble	■	■		■	■			■	■	■		■		■		■		■			■
	Fixing bath	■	■		■	■			■	■	■		■	■					■			■
	Varnish, water-based	■	■		■	■			■	■	■		■		■		■		■			■
	Varnish, partly water-based	■							■	■	■		■		■		■		■			■
	Lye, extreme		■		■	■									■		■			■		■
	Oil/water-emulsions	■							■	■	■		■		■		■			■		■
	Organic percentile high	■							■	■			■		■		■		■			■
	Paper extract	■	■		■	■			■	■	■		■		■		■		■			■
	Acid, extreme	■	■		■	■			■	■	■		■		■		■					■
	Sulphide containing liquid	■	■						■	■					■		■		■			■
	Suspension, water-based	■	■		■	■		■	■	■			■		■		■		■	■		■
	Ink	■	■		■	■			■	■			■		■		■		■			■
	Viscose samples	■				■				■			■		■		■			■		
Field measurements	Beck	■		■			■	■	■	■	■	■	■		■	■	■	■		■	■	
	Ground water	■		■			■	■	■	■	■	■	■		■	■	■	■		■	■	
	Lake water	■		■			■	■	■	■	■	■	■		■	■	■	■		■	■	
	Seawater	■		■			■	■	■	■	■	■	■		■	■	■	■		■	■	
	Rain water	■		■			■	■	■	■	■	■	■		■	■	■		■	■	■	
Drinks production	Beer	■		■			■	■	■	■	■	■	■		■	■	■			■	■	
	Fruit juice	■		■			■	■	■	■	■		■		■	■	■			■	■	
	Vegetable juice	■		■			■	■	■	■	■		■		■	■	■			■	■	
	Lemonades/soda	■		■			■	■	■	■	■	■	■		■	■	■			■	■	
	Mineral water	■		■			■	■	■	■	■	■	■		■	■	■			■	■	
	Juice	■		■			■	■	■	■	■		■		■	■	■			■	■	
	Spirits	■		■				■	■	■	■		■		■		■			■	■	
	Wine	■		■				■	■	■	■		■		■	■	■			■	■	
		IL-pH-A120MF	IL-pH-H120MF	A 7780	H 62	H 64	L 32	L 8280	N 62	N 64	11 pH	22 pH	13 pH	Ag 6280	Pt 62	Pt 8280	31 RX	32 RX	LF 313 T NFTC	LF 413 T	LF 613 T	LF 713 T

Further application recommendations for pH

Electrode series		pH measurement															ORP					Conductivity			
		IoLine		ScienceLine								BlueLine					ScienceLine			BlueLine		ScienceLine			
Application area	Sensor example / Application	IL-pH-A120MF	IL-SP-pH-A	A 7780	N 1048 A	L 32	L 39	L 6880	L 8280	N 62	N 64	11 pH	22 pH	13 pH	21 pH	27 pH	Pt 62	Pt 6140	Pt 8280	31 RX	32 RX	LF 313 T NFTC	LF 413 T	LF 613 T	LF 713 T
Cosmetics	Creme	■	■		■		■	■		■	■	■		■	■	■	■			■		■	■		
	Hair dye	■								■	■	■		■			■			■		■	■		
	Hair gel	■	■		■		■	■			■				■	■	■			■		■			
	Hair mousse	■								■	■	■		■			■			■		■	■		
	Lotions	■								■	■	■		■			■			■		■	■		
	Make-up	■								■	■	■		■		■	■			■			■		
	Mouth wash	■								■	■	■		■			■			■		■	■		
	Shaving cream	■								■	■	■		■			■			■		■	■		
	Sun lotion	■								■	■	■		■			■			■		■	■		
	Tooth paste		■		■		■	■			■	■		■	■	■	■			■		■	■		
Agriculture	Ground (extract/slug)	■		■		■			■	■	■	■		■			■		■	■	■		■		
	Fertilizer solution	■		■		■			■	■	■	■	■	■			■		■	■	■		■		
	Vegetables		■		■		■	■							■	■		■							
	Liquid manure	■		■		■			■	■	■	■		■			■		■	■	■		■		
	Fruit		■		■			■							■			■							
Food production	Bread/dough/pastry		■		■			■							■			■							
	Vinegar	■		■						■	■	■	■	■			■		■	■			■		■
	Grease	■								■	■	■		■			■			■			■		
	Fish		■		■			■							■			■							
	Meat		■		■			■							■			■							
	Honey		■		■			■						■	■		■			■			■		
	Margarine	■								■	■	■		■			■			■			■		
	Coffee extract	■								■	■	■		■			■		■	■			■	■	
	Jam/marmelade	■								■	■	■		■			■			■			■		
	Mayonnaise	■								■	■			■			■		■	■			■		
	Sausage		■		■		■	■							■	■		■							
Dairy	Butter	■	■							■	■				■		■			■			■		
	Yoghurt	■		■		■				■	■	■		■			■			■			■		
	Cheese		■		■		■	■		■	■				■	■	■			■					
	Milk	■		■		■				■	■	■		■			■			■			■		
	Cream	■								■	■	■		■			■			■			■		
Surface	Skin						■									■									
	Leather						■									■									
	Paper						■									■									
	Textiles						■									■									

IL-pH-A120MF IL-SP-pH-A A 7780 N 1048 A L 32 L 39 L 6880 L 8280 N 62 N 64 11 pH 22 pH 13 pH 21 pH 27 pH Pt 62 Pt 6140 Pt 8280 31 RX 32 RX LF 313 T NFTC LF 413 T LF 613 T LF 713 T

… ORP electrodes and conductivity cells

Electrode series		pH measurement																						ORP						Conductivity					
		IoLine				ScienceLine													BlueLine					ScienceLine				BL*		ScienceLine					
Application area	Sensor example / Application	IL-pH-A120MF	IL-pH-H120MF	IL-Micro-pH-A	IL-SP-pH-A	A 157	A 7780	H 62	H 64	N 1048 A	L 32	L 39	L 6880	L 8280	N 62	N 64	N 6000 A	N 6003	11 pH	22 pH	13 pH	16 pH	21 pH	27 pH	Pt 62	Pt 6140	Pt 8280	Pt 5900 A	31 RX	32 RX	LF 213 T	LF 313 T	LF 313 T NFTC	LF 413 T	LF 613 T	LF 713 T
Pharmacy, biology, biotechnology, medicine, microbiology	Agar-agar gel				■					■		■	■										■	■		■										
	Enzyme solution	■	■	■															■		■				■			■	■							■
	Infusion solutions	■	■	■											■	■			■		■				■				■							■
	Small vessels/sample quantitiy			■		■											■	■				■						■								
	Bacteria cultures	■	■	■		■	■								■	■	■	■	■		■	■			■				■							■
	Gastric juice		■												■	■			■		■				■				■							■
	NMR tubes																	■																		
	Precision measurement	■	■	■											■	■									■				■							
	Protein containing liquid	■	■	■											■	■									■				■							
	Serum	■	■	■		■									■	■	■	■				■			■			■	■							■
	Tris puffer	■		■																																■
	Urine	■	■	■											■	■			■		■				■				■							■
	Vials			■		■											■	■				■						■								
Techni-cal	Cooling water	■					■								■	■			■		■				■				■			■				
	Lye, hot		■					■	■																■				■							■
	Acid, hot		■					■	■																■				■							■
Washing agents	Detergents	■													■	■			■		■				■				■				■	■	■	■
	Disinfectant	■													■	■			■		■				■				■					■		■
	Cleaning agent	■													■	■			■		■				■				■				■	■		
	Soap solution	■													■	■			■		■				■				■				■	■		
	Dishwashing liquid	■													■	■			■		■				■				■				■	■		
	Surfactant solution	■													■	■			■		■				■				■				■	■		
Water	Waste water, general	■					■	■			■			■	■	■			■	■	■				■		■		■	■				■	■	
	Aquarium water	■					■				■				■	■			■	■	■				■		■		■	■				■	■	
	Demineralization/ion exchanger	■													■	■			■		■				■				■			■	■			
	pH values, extreme		■					■	■												■				■				■							■
	Media containing low ions	■					■								■	■			■		■				■				■			■	■			
	Boiler feed water	■					■								■	■			■		■				■				■		■	■	■			
	Condensate	■					■								■	■			■		■				■				■		■	■	■			
	Purity water	■														■			■		■				■				■		■					
	Salt solution		■				■	■			■			■					■		■				■		■		■	■				■	■	
	Drinking water	■					■								■	■			■		■				■		■		■	■		■	■	■	■	
	Drops											■												■												
		IL-pH-A120MF	IL-pH-H120MF	IL-Micro-pH-A	IL-SP-pH-A	A 157	A 7780	H 62	H 64	N 1048 A	L 32	L 39	L 6880	L 8280	N 62	N 64	N 6000 A	N 6003	11 pH	22 pH	13 pH	16 pH	21 pH	27 pH	Pt 62	Pt 6140	Pt 8280	Pt 5900 A	31 RX	32 RX	LF 213 T	LF 313 T	LF 313 T NFTC	LF 413 T	LF 613 T	LF 713 T

* BL = BlueLine

ID electrodes – reliable and precise pH measurements through automatic electrode recognition

Measurements with the utmost accuracy using complete systems

The demand for accuracy, reproducibility and primarily stability of the pH measurement is exceedingly high. It has become even more important to have an application focussed measurement system, consisting of electrodes, instrument and buffer solutions, as each measurement is unique. SI Analytics has taken this into account and offers premium components ideally corresponding to all your applications. Only a perfectly harmonising system will enable measurements of utmost accuracy.

Automatic electrode recognition guarantees the accuracy of the measurement

Basis for the accuracy of pH measurement is the calibration. So far the main efforts for optimizing the calibration focussed on instrument-based help functions, such as the automatic buffer recognition. Still the uncertainty regarding the electrode remained, not knowing for sure if the electrode was matches the calibration data stored with the instrument. To assure that the electrode's slope and zero point corresponded to the instrument stored data for calculation of the pH value it was necessary to re-calibrate.

The Lab 870 and 970 and the instruments of the ProLab family automatically recognizes the ID electrode. The ID sensors automatically transmit their individual data via a in the plug integrated micro transponder. The sensor data of the pH electrodes includes the slope and zero point, data of last calibration, buffer used as well as sensor type and serial number. The instrument uses this specific data for each corresponding ID electrode in order to calculate the pH value whether using the ID electrode with multiple instruments or various ID electrodes on one instrument.

GLP compliant documentation

Wireless sensor recognition

Continuous updating of sensor data

When the ID electrode is calibrated using with the Lab 870/970 or the ProLab instruments the data on the electrode are updated. The instrument will recognize and access the calibration data for the next measurement. This process runs in the background without any interaction by user. The result is taken with stable measurements and there is no need for repeated calibrations when changing the sensor.

Records include sensor type and serial number

The instruments also fulfil the increasing documentation requirements. The data, includes sensor type and serial number along with measurement values, data and time are part of the record, which can be transferred to the PC via interfaces.

Advantages ID

- Each ID sensor has a unique identification.
- **Highest reliability** – data exchange between sensor and instrument is fully automatic.
- Several ID sensors can be used with one instrument and one ID sensor can be used with multiple instruments via recognition, **without having to re-calibrate.**
- Accurate and reliable measurements with sensor specific data
- GLP at its best:
  Automatic and complete documentation of calibrations and measurements including the electrode used (model and serial number) with date, time and measurement values.

ID electrodes for highest reliability
... with fixed cable and integrated electrode recognition

ID electrodes for pH measurement

Shaft material:	glass
Zero point:	pH = 7.0 ± 0.3
pH range:	0 to 14
Reference system[1]:	iodine/iodide, Silamid®, Ag / AgCl
Reference electrolyte:	KCl 3 mol/l
Fixed cable:	1m long, with DIN or BNC plug and banana plug with the versions including an integrated temperature sensor

[1] please view the following pages for the technical data of each electrode

IL-pHT-A120-DIN-N — *IL-pHT-A120-BNC-N*
IL-pHT-A170-DIN-N — *IL-pHT-A170-BNC-N*
A 7780 1M-DIN-ID — *A 7780 1M-BNC-ID*
A 161 1M-DIN-ID — *A 161 1M-BNC-ID*
A 164 1M-DIN-ID — *A 164 1M-BNC-ID*
BlueLine 14 pH ID — *BlueLine 15 pH ID*

ID electrodes for conductivity measuring with temperature sensor

Temperature sensor:	NTC 30 kΩ
Fixed cable:	1 m long, 8-pole plug

* LFOX 1400 ID for oxygen measurement

LF 213 T-ID
LF 313 T-ID
LF 413 T-ID
LF 913 T-ID
LFOX 1400 ID*

A selection of our ID electrodes

ID electrodes for pH measuring

Micro, spear tip and surface combination electrodes

Shaft material:	glass (except BlueLine 21: plastic shaft)
Zero point:	pH = 7.0 ± 0.3
pH range:	0 to 14 (except BlueLine 21 and 27: 1 to 13 pH)
Reference system[1]:	iodine/iodide, Silamid®, Ag / AgCl
Reference electrolyte:	KCl 3 mol/l, gel or Referid®
Fixed cable:	1 m long, with DIN or BNC plug and banana plug with the versions including an integrated temperature sensor

IL-Micro-pHT-A-DIN-N
IL-Micro-pHT-A-BNC-N

L 6880 1M-DIN-ID
L 6880 1M-BNC-ID

N 1048 1M-DIN-ID
N 1048 1M-BNC-ID

L 39 1M-DIN-ID
L 39 1M-BNC-ID

N 6000 1M-DIN-ID
N 6000 1M-BNC-ID

BlueLine 21 pH 1M-DIN-ID
BlueLine 21 pH 1M-BNC-ID

BlueLine 27 pH 1M-DIN-ID
BlueLine 27 pH 1M-BNC-ID

[1] please view the following pages for the technical data of each electrode

IoLine pH combination electrodes

pH combination electrodes

Reference system:	iodine/iodide
Zero point:	pH = 7,00 ± 0.25
pH range:	0 to 14
Temp. range:	– 5 to 100 °C
Shaft material:	glass

A IL-pH-A120-MF
IL-pH-A120

B IL-pH-A170-MF
IL-pH-A170

C IL-pH-A120-MF-DIN
IL-pH-A120-DIN
IL-pH-A120-MF-BNC
IL-pH-A120MF-R
IL-pH-A120-BNC

D IL-pH-A170-MF-DIN
IL-pH-A170-DIN
IL-pH-A170-MF-BNC
IL-pH-A170MF-R
IL-pH-A170-BNC

E IL-Micro-pH-A
IL-Micro-pH-A-DIN
IL-Micro-pH-A-BNC

F IL-SP-pH-A
IL-SP-pH-A-DIN
IL-SP-pH-A-BNC

Glossary

IL	IoLine
Micro	micro pH electrode for measuring in small sample vessels
SP	spear tip pH electrode for measuring in solid and semi-solid samples
pH	pH combination electrodes
pHT	pH combination electrodes with temperature sensor
A	A-type membrane glass
H	H-type membrane glass
120	120 mm overall length
170	170 mm overall length
MF	platinum junction (multi-flow)
DIN	DIN instrument plug
BNC	BNC instrument plug
R	Metrohm plug
N	4 mm banana plug
CI	cinch plug

Type No.	Order No.	Length L [mm]	Ø [mm]	Junction	Membrane glass	Membrane glass resistance	Membrane shape	Connection	Appli-cation	Shape
IL-pH-A120MF	285114140	120	12	platinum	A	200 MΩ	sphere	Screw plug head S7	■	A
IL-pH-A120	285114150	120	12	ceramic	A	200 MΩ	sphere	Screw plug head S7	■	A
IL-pH-A170MF	285114180	170	12	platinum	A	200 MΩ	sphere	Screw plug head S7	■	B
IL-pH-A170	285114190	170	12	ceramic	A	200 MΩ	sphere	Screw plug head S7	■	B
IL-pH-A120MF-DIN	285113810	120	12	platinum	A	200 MΩ	sphere	DIN[1]	■	C
IL-pH-A120-DIN	285113820	120	12	ceramic	A	200 MΩ	sphere	DIN[1]	■	C
IL-pH-A120MF-BNC	285114160	120	12	platinum	A	200 MΩ	sphere	BNC[1]	■	C
IL-pH-A120-BNC	285114170	120	12	ceramic	A	200 MΩ	sphere	BNC[1]	■	C
IL-pH-A120MF-R	285114410	120	12	platinum	A	200 MΩ	sphere	Metrohm plug[1]	■	C
IL-pH-A170MF-DIN	285113830	170	12	platinum	A	200 MΩ	sphere	DIN[1]	■	D
IL-pH-A170-DIN	285113840	170	12	ceramic	A	200 MΩ	sphere	DIN[1]	■	D
IL-pH-A170MF-BNC	285114340	170	12	platinum	A	200 MΩ	sphere	BNC[1]	■	D
IL-pH-A170-BNC	285114350	170	12	ceramic	A	200 MΩ	sphere	BNC[1]	■	D
IL-pH-A170MF-R	285114420	170	12	platinum	A	200 MΩ	sphere	Metrohm plug[1]	■	D
IL-MICRO-pH-A	285114280	200 (70 / 130)	12 / 6	platinum	A	400 MΩ	cylindrical	Screw plug head S7	■	E
IL-MICRO-pH-A-DIN	285113930	200 (70 / 130)	12 / 6	platinum	A	400 MΩ	cylindrical	DIN[1]	■	E
IL-MICRO-pH-A-BNC	285114290	200 (70 / 130)	12 / 6	platinum	A	400 MΩ	cylindrical	BNC[1]	■	E
IL-SP-pH-A	285114320	120 (50 / 70)	12 / 8	ceramic	A	400 MΩ	spear	Screw plug head S7	■	F
IL-SP-pH-A-DIN	285113940	120 (50 / 70)	12 / 8	ceramic	A	400 MΩ	spear	DIN[1]	■	F
IL-SP-pH-A-BNC	285114330	120 (50 / 70)	12 / 8	ceramic	A	400 MΩ	spear	BNC[1]	■	F

■ general applications, low ion media

■ small sample quantities

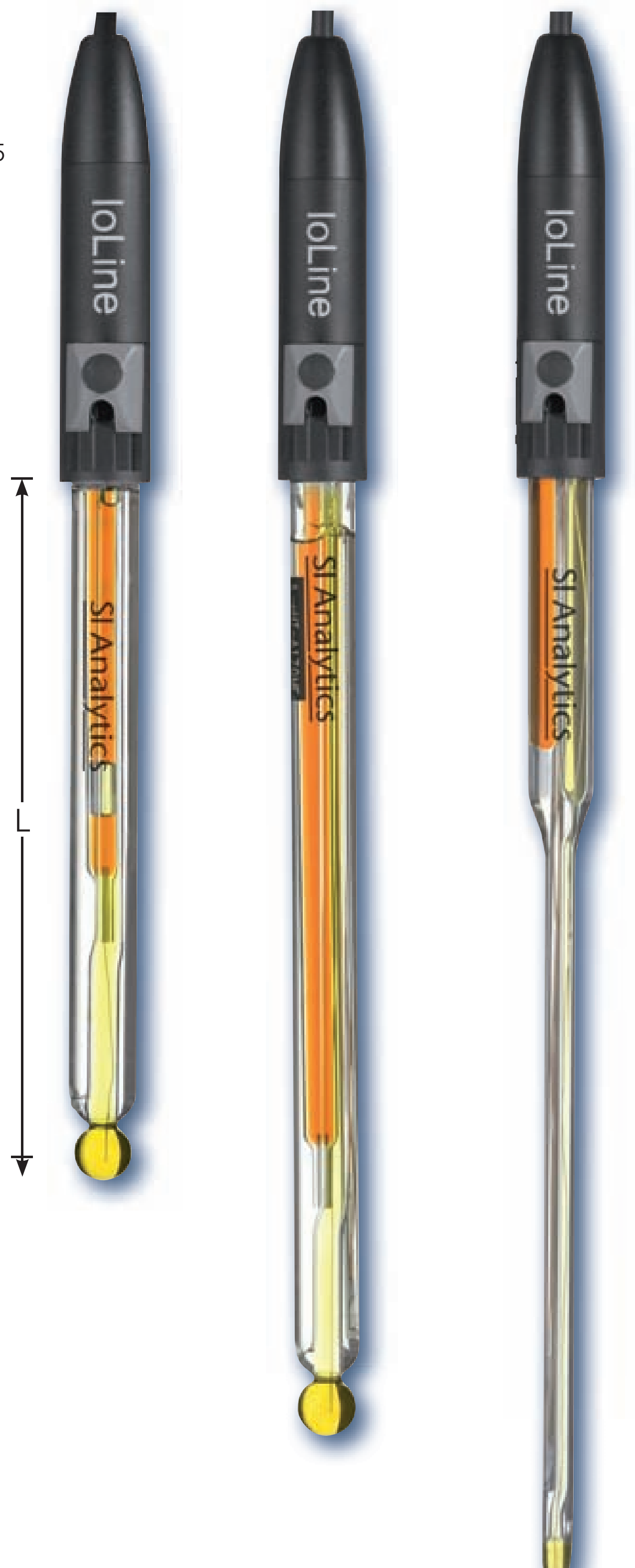
■ insert measurement

[1] with 1 m fixed cable

IoLine pH combination electrodes with temperature sensor

pH combination electrodes with temperature sensor

Reference system:	iodine/iodide
Zero point:	pH = 7,00 ± 0.25
pH range:	0 to 14
Temp. range:	–5 to 100 °C
Shaft material:	glass



A B C

A IL-pHT-A120MF-DIN-N
IL-pHT-A120-DIN-N
IL-pHT-A120MF-BNC-CI
IL-pHT-A120MF-R-NN
IL-pHT-A120MF-BNC-N
IL-pHT-A120-BNC-N
IL-pHT-H120MF-DIN-N
IL-pHT-H120-DIN-N
IL-pHT-H120MF-BNC-N
IL-pHT-H120-BNC-N

B IL-pHT-A170MF-DIN-N
IL-pHT-A170-DIN-N
IL-pHT-A170MF-BNC-CI
IL-pHT-A170MF-R-NN
IL-pHT-A170MF-BNC-N
IL-pHT-A170-BNC-N
IL-pHT-H170MF-DIN-N
IL-pHT-H170-DIN-N
IL-pHT-H170MF-BNC-N
IL-pHT-H170-BNC-N

C IL-MICRO-pHT-A-DIN-N
IL-MICRO-pHT-A-BNC-N

Glossary

IL	IoLine
Micro	micro pH electrode for measuring in small sample vessels
SP	spear tip pH electrode for measuring in solid and semi-solid samples
pH	pH combination electrodes
pHT	pH combination electrodes with temperature sensor
A	A-type membrane glass
H	H-type membrane glass
120	120 mm overall length
170	170 mm overall length
MF	platinum junction (multi-flow)
DIN	DIN instrument plug
BNC	BNC instrument plug
R	Metrohm plug
N	4 mm banana plug
CI	cinch plug

Type No.	Order No.	Length L [mm]	Ø [mm]	Junction	Membrane glass	Membrane glass resistance	Membrane shape	Temp. sensor	ID Function	Connection with 1 m fixed cable	Appli-cation	Shape
IL-pHT-A120MF-DIN-N	285113890	120	12	platinum	A	200 MΩ	sphere	Pt 1000	yes	DIN + banana plug	[blue]	A
IL-pHT-A120-DIN-N	285113900	120	12	ceramic	A	200 MΩ	sphere	Pt 1000	yes	DIN + banana plug	[blue]	A
IL-pHT-A120MF-BNC-N	285113850	120	12	platinum	A	200 MΩ	sphere	Pt 1000	yes	BNC + banana plug	[blue]	A
IL-pHT-A120-BNC-N	285113860	120	12	ceramic	A	200 MΩ	sphere	Pt 1000	yes	BNC + banana plug	[blue]	A
IL-pHT-H120MF-DIN-N	285113870	120	12	platinum	H	300 MΩ	sphere	Pt 1000	yes	DIN + banana plug	[grey]	A
IL-pHT-H120-DIN-N	285113880	120	12	ceramic	H	300 MΩ	sphere	Pt 1000	yes	DIN + banana plug	[grey]	A
IL-pHT-H120MF-BNC-N	285114200	120	12	platinum	H	300 MΩ	sphere	Pt 1000	yes	BNC + banana plug	[grey]	A
IL-pHT-H120-BNC-N	285114210	120	12	ceramic	H	300 MΩ	sphere	Pt 1000	yes	BNC + banana plug	[grey]	A
IL-pHT-A120MF-BNC-CI	285114370	120	12	platinum	A	200 MΩ	sphere	NTC 30 kΩ		BNC + cinch	[blue]	A
IL-pHT-A120MF-R-NN	285114390	120	12	platinum	A	200 MΩ	sphere	Pt 1000		Metrohm plug + 2 banana plug	[blue]	A
IL-pHT-A170MF-DIN-N	285113910	170	12	platinum	A	200 Mohm	sphere	Pt 1000	yes	DIN + banana plug	[blue]	B
IL-pHT-A170-DIN-N	285113920	170	12	ceramic	A	200 MΩ	sphere	Pt 1000	yes	DIN + banana plug	[blue]	B
IL-pHT-A170MF-BNC-N	285114220	170	12	platinum	A	200 MΩ	sphere	Pt 1000	yes	BNC + banana plug	[blue]	B
IL-pHT-A170-BNC-N	285114230	170	12	ceramic	A	200 MΩ	sphere	Pt 1000	yes	BNC + banana plug	[blue]	B
IL-pHT-H170MF-DIN-N	285114240	170	12	platinum	H	300 MΩ	sphere	Pt 1000	yes	DIN + banana plug	[grey]	B
IL-pHT-H170-DIN-N	285114250	170	12	ceramic	H	300 MΩ	sphere	Pt 1000	yes	DIN + banana plug	[grey]	B
IL-pHT-H170MF-BNC-N	285114260	170	12	platinum	H	300 MΩ	sphere	Pt 1000	yes	BNC + banana plug	[grey]	B
IL-pHT-H170-BNC-N	285114270	170	12	ceramic	H	300 MΩ	sphere	Pt 1000	yes	BNC + banana plug	[grey]	B
IL-pHT-A170MF-BNC-CI	285114380	170	12	platinum	A	200 MΩ	sphere	NTC 30 kΩ		BNC + cinch	[blue]	B
IL-pHT-A170MF-R-NN	285114400	170	12	platinum	A	200 MΩ	sphere	Pt 1000		Metrohm plug + 2 banana plug	[blue]	B
IL-MICRO-pHT-A-DIN-N	285114300	200 (70/130)	12/6	platinum	A	400 MΩ	cylindrical	Pt 1000	yes	DIN + banana plug	[light blue]	C
IL-MICRO-pHT-A-BNC-N	285114310	200 (70/130)	12/6	platinum	A	400 MΩ	cylindrical	Pt 1000	yes	BNC + banana plug	[light blue]	C

[blue] general applications, low ion media

[light blue] small sample quantities

[grey] high temperatures, optimized for alkaline area

ScienceLine pH combination electrodes

pH combination electrodes with plug head and fixed cable

Reference system:	Silamid®
Shaft material:	glass
Zero point:	pH = 7.0 ± 0.3
Electrolyte:	KCl 3 mol/l (except N 6250: KCl 4.2 mol/l, A 7780 and L 7780: gel electrolyte, L 8280: Referid® electrolyte)
Membrane shape:	sphere
pH range:	0 to 14
Connection cable for plug head:	e.g. L 1 A (See also page with connection cables)
fixed cable:	1 m long, with plug A acc. to DIN 19262 or with BNC plug

H 61	H 64	N 65	L 32	A 7780	N 6980	L 8280
H 62	*H 64 1M-DIN-ID*	*H 65*		*L 7780*		
H 63	*H 64 1M-BNC-ID*	*H 6580*				
N 61	*N 64*	*N 6580*				
N 62	*N 6480 eis*					
H 6180	*N 6480 eth*					
H 6280						
H 6380						
N 6180						
N 6250						
N 6280						
N 42 A						
N 42 BNC						
N 50 A						
N 52 A						
N 52 BNC						
N 61 eis						
H 61-500						
H 61-600						

Order No.	Type No.	Length L [mm]	Ø [mm]	Junction	pH-glass	Temp. range [°C]	Connection	Remarks
285101260	A 7780	120	12	3 x ceramic	A	-5 to +80	plug head	gel electrolyte
285100207	H 61	170	12	platinum	H	+10 to +100	plug head	
285092583	H 61-500	500	12	platinum	H	0 to +100	plug head	
285092591	H 61-600	600	12	platinum	H	0 to +100	plug head	
285102524	H 6180	170	12	ceramic	H	+10 to +100	plug head	
285100215	H 62	120	12	platinum	H	+10 to +100	plug head	
285102532	H 6280	120	12	ceramic	H	+10 to +100	plug head	
285100223	H 63	320	12	platinum	H	+10 to +100	plug head	
285102549	H 6380	320	12	ceramic	H	+10 to +100	plug head	
285100231	H 64	170	12	ground joint	H	+10 to +100	plug head	
285130220	H 64 1M-DIN-ID	170	12	ground joint	H	+10 to +100	DIN plug[2)]	ID function
285130230	H 64 1M-BNC-ID	170	12	ground joint	H	+10 to +100	BNC plug[2)]	ID function
285100248	H 65	103[1)]	10	platinum	H	+10 to +100	plug head	standard taper NS 14.5
285102565	H 6580	103[1)]	10	ceramic	H	+10 to +100	plug head	standard taper NS 14.5
1061093	L 32	120	12	fibre	A	-5 to +50	plug head	plastic shaft
285101252	L 7780	120	12	ceramic	A	-5 to +80	plug head	gel electrolyte
285101277	L 8280	120	12	KPG®	A	-5 to +80	plug head	Referid® electrolyte
285100437	N 42 A	120	12	ceramic	A	-5 to +100	DIN plug[2)]	
285101544	N 42 BNC	120	12	ceramic	A	-5 to +100	BNC plug[2)]	
285100453	N 50 A	108	12	ceramic	A	-5 to +100	DIN plug[2)]	for portable Knick pH meters
285100494	N 52 A	120	12	platinum	A	-5 to +100	DIN plug[2)]	
285105451	N 52 BNC	120	12	platinum	A	-5 to +100	BNC plug[2)]	
285100001	N 61	170	12	platinum	A	-5 to +100	plug head	
285100018	N 6180	170	12	ceramic	A	-5 to +100	plug head	
285100034	N 62	120	12	platinum	A	-5 to +100	plug head	
285100112	N 6250	120	12	ceramic	A	+15 to +40	plug head	calomel ref., for TRIS buffers
285100042	N 6280	120	12	ceramic	A	-5 to +100	plug head	
285100059	N 64	170	12	ground joint	A	-5 to +100	plug head	
285100067	N 65	103[1)]	10	platinum	A	-5 to +100	plug head	standard taper NS 14.5
285102516	N 6580	103[1)]	10	ceramic	A	-5 to +100	plug head	standard taper NS 14.5
285101709	N 6980	103[1)]	10	ground joint	A	-5 to +100	plug head	standard taper NS 14.5
285092661	N 61eis	170	12	3 x platinum	A	+10 to +40	plug head	electrolyte L 5014, Ag/AgCl ref.
285092337	N 6480 eis	170	12	ground joint	A	+10 to +40	plug head	electrolyte L 5014, Ag/AgCl ref.
285092329	N 6480 eth	170	12	ground joint	A	0 to +40	plug head	electrolyte L 5014, Ag/AgCl ref.

[1)] Length from upper end of standard taper
[2)] with 1 m fixed cable

ScienceLine pH combination electrodes with temperature sensor

pH combination electrodes with temperature sensor

Reference system:	Silamid®
Shaft material:	glass
Diameter:	12 mm
Zero point:	pH = 7.0 ± 0.3
Electrolyte:	KCl 3 mol/l
Temperature sensor:	Pt 1000
Membrane shape:	sphere
pH range:	0 to 14
Connection cable:	
for SMEK-plug head:	e.g. LS 1 ANN (See also page with connection cables)
fixed cable:	1 m long, with plug A acc. to DIN 19262 or with BNC plug, as well as plug for temperature sensor

N 1042 A
N 1041 A
N 1041BNC
N 1042 BNC
N 1050 A
N 1051 A
N 1051 BNC
N 1052 A
N 1052 BNC
N 2041 A
N 2042 A
N 1041 A - 600
N 1043 A

A 162
A 161
H 161
H 162
A 161 1M DIN ID
A 161 1M BNC ID
H 161 1M DIN ID
H 161 1M BNC ID

A 164
A 164 1M DIN ID
A 164 1M BNC ID

A 7780 1M DIN ID
A 7780 1M BNC ID

Order No.	Type No.	Length L [mm]	Junction	pH-glass	Temp.-range [°C]	Connection	Remarks
285129517	A 161	170	platinum	A	–5 to +100	SMEK plug head	
285130240	A 161 1M-DIN-ID	170	platinum	A	–5 to +100	DIN[1]- + 4-mm plug	ID function
285130250	A 161 1M-BNC-ID	170	platinum	A	–5 to +100	BNC[1]- + 4-mm plug	ID function
285129525	A 162	120	platinum	A	–5 to +100	SMEK plug head	
285129600	A 164	170	ground joint	A	–5 to +100	SMEK plug head	
285130280	A 164 1M-DIN-ID	170	ground joint	A	–5 to +100	DIN[1]- + 4-mm plug	ID function
285130290	A 164 1M-BNC-ID	170	ground joint	A	–5 to +100	BNC[1]- + 4-mm plug	ID function
285130200	A 7780 1M-DIN-ID	120	3 x ceramic	A	–5 to +80	DIN-[1] + 4-mm plug	ID function
285130210	A 7780 1M-BNC-ID	120	3 x ceramic	A	–5 to +80	BNC-[1] + 4-mm plug	ID function
285129590	H 161	170	platinum	H	+10 to +100	SMEK plug head	
285130260	H 161 1M-DIN-ID	170	platinum	H	+10 to +100	DIN[1]- + 4-mm plug	ID function
285130270	H 161 1M-BNC-ID	170	platinum	H	+10 to +100	BNC[1]- + 4-mm plug	ID function
285129580	H 162	120	platinum	H	+10 to +100	SMEK plug head	
285100486	N 1041 A	170	ceramic	A	–5 to +100	DIN-[1] + 4-mm plug	
285093111	N 1041 A-600	600	ceramic	A	–5 to +100	DIN-[1] + 4-mm plug	Ag/AgCl ref.
285100531	N 1041 BNC	170	ceramic	A	–5 to +100	BNC-[1] + 4-mm plug	
285104541	N 1042 A	120	ceramic	A	–5 to +100	DIN-[1] + 4-mm plug	
285105476	N 1042 BNC	120	ceramic	A	–5 to +100	BNC-[1] + 4-mm plug	
285093009	N 1043 A	320	ceramic	A	–5 to +100	DIN-[1] + 4-mm plug	
285100375	N 1050 A	108	ceramic	A	–5 to +100	DIN-[1] + 4-mm plug	for portable Knick pH Meter
285100510	N 1051 A	170	platinum	A	–5 to +100	DIN-[1] + 4-mm plug	
285100500	N 1051 BNC	170	platinum	A	–5 to +100	BNC-[1] + 4-mm plug	
1054512	N 1052 A	120	platinum	A	–5 to +100	DIN-[1] + 4-mm plug	
285100380	N 1052 BNC	120	platinum	A	–5 to +100	BNC-[1] + 4-mm plug	
285100342	N 2041 A	170	ceramic	A	–5 to +100	DIN-[1] + 2-mm plug	
285100359	N 2042 A	120	ceramic	A	–5 to +100	DIN-[1] + 2-mm plug	

[1] with 1 m fixed cable

ScienceLine micro, spear tip and surface pH combination electrodes

Micro, spear tip and surface pH combination electrodes

Reference system: Silamid®
Shaft material: glass (except L 39: plastic shaft)
Zero point: pH = 7.0 ± 0.3
Electrolyte: KCl 3 mol/l (except L8880: Referid®)
Type of membrane glass: A
Connection cable:
for SMEK plug head: e.g. LS 1 ANN (See also page with connection cables)
for plug head versions: e.g. L 1 A (See also page with connection cables)
fixed cable: 1 m long, with plug A acc. to DIN 19262 or with BNC plug, as well as plug for temperature sensor

A 157 1M BNC ID	N 5800 A	N 6000 1M DIN ID	N 6003	L 6880	N 1048 A	L 39
A 157	*N 5800 BNC*	*N 6000 1M BNC ID*		*L 6880 1M-DIN-ID*	*N 1048 1M DIN ID*	*L 39 1M DIN ID*
A 157 1M DIN ID	*N 5900 A*	*N 6000 A*		*L 6880 1M-BNC-ID*	*N 1048 1M DIN ID*	*L 39 1M DIN ID*
		N 6000 BNC		*L 8880*	*N 48 A*	
					N 48 BNC	

Order No.	Type No.	Length L [mm]	Ø [mm]	Junction	pH-glass	Membrane shape	Temp.-range [°C]	Range [pH]	Connection	Remarks
Micro										
285129610	A 157[1]	70/130	12/5	platinum	A	cylindrical	-5 to +100	0 to 14	SMEK plug head	
285130160	A 157 1M-DIN-ID[1]	70/130	12/5	platinum	A	cylindrical	-5 to +100	0 to 14	DIN plug[3]	ID function
285130170	A 157 1M-BNC-ID[1]	70/130	12/5	platinum	A	cylindrical	-5 to +100	0 to 14	BNC plug[3]	ID function
285105127	N 5800 A	96[2]	5	3 x platinum	A	spear	-5 to +100	0 to 14	DIN plug[3]	Ag/AgCl ref.
285105579	N 5800 BNC	96[2]	5	3 x platinum	A	spear	-5 to +100	0 to 14	BNC plug[3]	Ag/AgCl ref.
285105135	N 5900 A	96[2]	5	platinum	A	sphere	-5 to +100	0 to 14	DIN plug[3]	Ag/AgCl ref.
285105151	N 6000 A	96[2]	3	platinum	A	cylindrical	-5 to +100	0 to 14	DIN plug[3]	Ag/AgCl ref.
285105632	N 6000 BNC	96[2]	3	platinum	A	cylindrical	-5 to +100	0 to 14	BNC plug[3]	Ag/AgCl ref.
285130180	N 6000 1M-DIN-ID	96[2]	3	platinum	A	cylindrical	-5 to +100	0 to 14	DIN plug[3]	ID function, Ag/AgCl ref.
285130190	N 6000 1M-BNC-ID	96[2]	3	platinum	A	cylindrical	-5 to +100	0 to 14	BNC plug[3]	ID function, Ag/AgCl ref.
285105176	N 6003	70/180	12/3	ceramic	A	cylindrical	-5 to +100	0 to 14	plug head	Ag/AgCl ref.
Spear tip										
285101211	L 6880	70/50	12/8	3 x ceramic	A	spear	-5 to +100	0 to 14	plug head	
285130100	L 6880 1M-DIN-ID	70/50	12/8	3 x ceramic	A	spear	-5 to +100	0 to 14	DIN plug[3]	ID function
285130110	L 6880 1M-BNC-ID	70/50	12/8	3 x ceramic	A	spear	-5 to +100	0 to 14	BNC plug[3]	ID function
285101285	L 8880	70/50	12/8	hole	A	spear	-5 to +80	2 to 13	plug head	
285104611	N 1048 A[1]	120	12	ceramic	A	spear	-5 to +100	0 to 14	DIN-[3] + 4-mm plug	
285130120	N 1048 1M-DIN-ID[1]	120	12	ceramic	A	spear	-5 to +100	0 to 14	DIN-[3] + 4-mm plug	ID function
285130130	N 1048 1M-BNC-ID[1]	120	12	ceramic	A	spear	-5 to +100	0 to 14	BNC-[3] + 4-mm plug	ID function
285100445	N 48 A	120	12	ceramic	A	spear	-5 to +100	0 to 14	DIN plug[3]	
285101569	N 48 BNC	120	12	ceramic	A	spear	-5 to +100	0 to 14	BNC plug[3]	
Surface										
1061094	L 39	120	12	fibre	A	flat	-5 to +50	1 to 13	plug head	
285130140	L 39 1M-DIN-ID	120	12	fibre	A	flat	-5 to +50	1 to 13	DIN plug[3]	ID function
285130150	L 39 1M-BNC-ID	120	12	fibre	A	flat	-5 to +50	1 to 13	BNC plug[3]	ID function

[1] with integrated temperature sensor Pt 1000
[2] Length from upper end of standard taper (Standard taper NS 7.5)
[3] with 1 m fixed cable

ScienceLine metal combination electrodes

Metal combination electrodes with Silver/Silverchloride reference system, plug head and connection cable

Temperature range:	– 5 to + 100 °C (except Pt 6140: + 10 to + 40 °C)
Reference system:	Silamid®
Shaft material:	glass
Electrolyte:	KCl 3 mol/l (See also remarks)
Connection cable:	
for plug head:	e.g. L 1 A (See also page with connection cables)
fixed cable:	1 m long, with plug A acc. to DIN 19262 or with BNC plug

Metal-Reference electrodes with pH glass membrane reference system and plug head for titrations

Temperature range:	-5 to + 100 °C
Reference system:	pH glass membrane Type A
Shaft material:	glass
Length:	120 mm
Diameter:	12 mm
Connection cable	
for plug head:	z.B. L 1 A

(please refer to the page “connection cables”)

AgCl 62	Pt 61	Pt 6880	Pt 6140	Pt 8280	Pt 5900 A	Pt 62 RG
AgCl 65	*Pt 62*	*Pt 6980*			*Pt 5900 BNC*	*Ag 62 RG*
Ag 42 A	*Pt 6180*	*Pt 48 A*			*Pt 5901*	*AgCl 62 RG*
Ag 6180	*Pt 6280*					*AgS 62 RG*
Ag 6280	*Pt 6580*					
Ag 6580	*Pt 42 A*					
AgCl 6280						
Au 6280						

Order No.	Type No.	Length L [mm]	Junction	Ø [mm]	Sensor Metal, shape	Connection	Remarks
285102051	Ag 42 A	120	ceramic	12	Ag, cap, 5 mm Ø	DIN plug[4]	electrolyte L 2114, Ag/AgCl ref.
285102208	Ag 6180	170	ceramic	12	Ag, cap, 5 mm Ø	plug head	electrolyte L 2114, Ag/AgCl ref.
285102343	Ag 6280	120	ceramic	12	Ag, cap, 5 mm Ø	plug head	electrolyte L 2114, Ag/AgCl ref.
285102216	Ag 6580	103[1]	ceramic	10	Ag, cap, 5 mm Ø	plug head	electrolyte L 2114, Ag/AgCl ref.
285102351	AgCl 6280[3]	120	ceramic	12	Ag, cap, 5 mm Ø	plug head	electrolyte L 2114, Ag/AgCl ref.
285102413	AgCl 62[3]	120	platinum	12	Ag, cap, 5 mm Ø	plug head	electrolyte L 2114, Ag/AgCl ref.
1061051	AgCl 65[3]	103[1]	platinum	12	Ag, cap, 5 mm Ø	plug head	electrolyte L 2114, Ag/AgCl ref.
285102121	Au 6280	120	ceramic	12	Au, pole, 2 mm Ø	plug head	
285102302	Pt 42 A	120	ceramic	12	Pt, pole, 1 mm Ø	DIN plug[4]	
285102224	Pt 48 A	120	ceramic	12	Pt, ring, 6 mm Ø	DIN plug[4]	Ag/AgCl ref.
285105192	Pt 5900 A	96[2]	platinum	5	Pt, pole, 1 mm Ø	DIN plug[4]	Ag/AgCl ref.
285105702	Pt 5900 BNC	96[2]	platinum	5	Pt, pole, 1 mm Ø	BNC plug[4]	Ag/AgCl ref.
285105065	Pt 5901	160[2]	platinum	5	Pt, pole, 1 mm Ø	plug head	
285102002	Pt 61	170	platinum	12	Pt, pole, 1 mm Ø	plug head	
285102019	Pt 62	120	platinum	12	Pt, pole, 1 mm Ø	plug head	
285097162	Pt 6140	150/20	platinum	12/5	Pt, pole, 1 mm Ø	plug head	for spear tip, electrolyte L420
285102232	Pt 6180	170	ceramic	12	Pt, pole, 1 mm Ø	plug head	
285102249	Pt 6280	120	ceramic	12	Pt, pole, 1 mm Ø	plug head	
285102257	Pt 6580	103[1]	ceramic	10	Pt, pole, 1 mm Ø	plug head	
285100075	Pt 6880	120	ceramic	12	Pt, ring, 6 mm Ø	plug head	
285102265	Pt 6980	170	ceramic	12	Pt, ring, 6 mm Ø	plug head	
285102281	Pt 8280	120	KPG®	12	Pt, round, 6 mm Ø	plug head	electrolyte Referid®
285102090	Ag 62 RG	120	–	12	Pt bearing – silver coated, ring, 6 mm Ø	plug head	
285102100	AgCl 62 RG	120	–	12	Pt-bearing – silver coated, chlorinated, ring, 6 mm Ø	plug head	
285102110	AgS 62 RG	120	–	12	Pt bearing – silver coated, sulfidized, ring, 6 mm Ø	plug head	
285102070	Pt 62 RG	120	–	12	Pt, ring, 6 mm Ø	plug head	

[1] Length from upper end of standard taper; standard taper NS 14.5
[2] Length from upper end of standard taper; standard taper NS 7.5
[3] Sensor coated with AgCl
[4] with 1 m fixed cable

ScienceLine single electrodes:
pH glass electrodes and metal electrodes

ScienceLine single electrodes

pH glass electrodes

Reference system:	Silamid®
Shaft material:	glass, 12 mm Ø
Zero point:	pH = 7.0 ± 0.3
Membrane shape:	sphere
Connection cable:	e.g. L 1 A

Metal electrodes

Shaft material:	glass, 12 mm Ø (See remarks)

A 1180
H 1180

Ag 1100

KF 1100

Pt 1400
Pt 1200

Pt 1800

Order No.	Type No.	Length L [mm]	pH Glass	Range [pH]	Temp.-range [°C]	Remarks
1057997	A 1180)	120	H	0 to 14	0 to + 80	plug head
285103212	H 1180	120	H	0 to 14	10 to + 100	plug head

Order No.	Type No.	Length L [mm]	Sensor Metal	Sensor shape	Temp. range [°C]	Remarks
285103607	Ag 1100	120	Ag	cap, 4 mm Ø	– 5 to + 100	plug head, cable e.g. L 1 A
285102030	KF 1100	96[1)]	Pt[2)]	2 pole, 1 mm Ø	– 30 to + 135	shaft 5 mm Ø, standard taper NS 7.5, fixed cable, 2 x 4-mm plug
285103512	Pt 1200	120	Pt[2)]	2 pole, 1 mm Ø	– 30 to + 135	plug head, cable e.g. L 1 NN
285103537	Pt 1400	103[1)]	Pt[2)]	2 pole, 1 mm Ø	– 30 to + 135	shaft 10 mm Ø, standard taper NS 14.5, cable e.g. L 1 NN
285103553	Pt 1800	120	Pt	ring, 6 mm Ø	– 30 to + 135	plug head, cable e.g. L 1 A

1) Length from upper end of standard taper
2) Double platinum electrode

ScienceLine single electrodes: Reference electrodes

Reference electrodes

Shaft material:	glass
Electrolyte depending on reference system:	
Ag/AgCl:	KCl 3 mol/l, e.g. L 300
Calomel:	KCl 4.2 mol/l, e.g. L 420
Hg/Hg_2SO_4:	K_2SO_4 0.6 mol/l, e.g. L 1254
pH range:	0 to 14
Connection cable:	e.g. L 1 N

B 2220+

B 2420+

B 2810+
B 2820+
B 2910+
B 2920+

B 3420+
B 3410+
B 3510+
B 3520+
B 3610+

B 3920+

Order No.	Type No.	Length L [mm]	Ø [mm]	Temp. range [°C]	Junction	Reference system	Remarks
1069994	B 2220 +	120	12	– 5 to + 100	platinum	Ag / AgCl	double electrolyte system
1070028	B 2420 +	120	12	– 5 to + 100	ground joint	Ag / AgCl	
1070029	B 2810 +	120	12	+ 15 to + 40	ceramic	Calomel	
1070044	B 2820 +	120	12	– 5 to + 100	ceramic	Ag / AgCl	
1070077	B 2910 +	120	12	+ 15 to + 40	platinum	Calomel	
1070046	B 2920 +	120	12	– 5 to + 100	platinum	Ag / AgCl	
1070048	B 3410 +	103[1)]	10	+ 15 to + 40	ceramic	Calomel	standard taper NS 14.5
1070070	B 3420 +	103[1)]	10	– 5 to + 100	ceramic	Ag / AgCl	standard taper NS 14.5
1070100	B 3510 +	103[1)]	10	+ 15 to + 40	platinum	Calomel	standard taper NS 14.5
1070073	B 3520 +	103[1)]	10	– 5 to + 100	platinum	Ag / AgCl	standard taper NS 14.5
1070074	B 3610 +	103[1)]	10	+ 15 to + 40	ceramic	Hg / Hg_2SO_4	standard taper NS 14.5
1070075	B 3920 +	103[1)]	10	– 5 to + 100	ground joint	Ag / AgCl	double electrolyte system, standard taper NS 14.5

[1)] Length from upper end of standard taper

ScienceLine conductivity measuring cells with fixed cable

Conductivity measuring cells with fixed cable and 8-pole plug

Temperature sensor: NTC 30 kΩ

LF 213 T	LF 313 T NTFC	LF 413 T-3	LF 513 T	LF 713 T	LF 913 T	LFOX 1400
LF 213 T ID	*LF 313 T*	*LF 413 T*	*LF 613 T*	*LF 713 T-250*	*LF 913 T ID*	*LFOX 1400 ID*
	LF 313 T ID	*LF 413 T ID*	*LF 813 T*			

Order No.	Type No.	Length L [mm]	Ø [mm]	Sensor	Cell const. ~ [cm⁻¹]	Temp. range [°C]	Meas. range[1)] [µS/cm]. . .[mS/cm]	Remarks
285106150	LF 213 T	120	12	Stainless steel	0.01	0 to + 100	0 to 0.03	Trace conductivity cell with integrated flow-through vessel, stainless steel, 1.5 m cable
285106160	LF 213 T ID	120	12	Stainless steel	0.01	0 to + 100	0 to 0.03	Trace conductivity cell with integrated flow-through vessel, stainless steel, 1.5 m cable, ID function
285414360	LF 313 T	120	12	Stainless steel	0.1	0 to + 100	0 to 0.2	Ultrapure water conductivity cell **with** flow-through vessel, stainless steel shaft, fixed cable 1.5 m
285130300	LF 313 T-ID	120	12	Stainless steel	0.1	0 to + 100	0 to 0.2	Ultrapure water conductivity cell **with** flow-through vessel, stainless steel shaft, cable 1.5 m, ID function
285414351	LF 313 T NFTC	120	12	Stainless steel	0.1	0 to + 100	0 to 0.2	Ultrapure water conductivity cell **without** flow-through vessel, stainless steel shaft, fixed cable 1.5 m
285106172	LF 413 T	120	15.3	4 x Graphite	0.475	– 5 to + 80	1 to 2,000	Plastic shaft, 1.5 m cable
285130310	LF 413 T-ID	120	15.3	4 x Graphite	0.475	– 5 to + 80	1 to 2,000	Plastic shaft, 1.5 m cable, ID function
285106148	LF 413 T-3	120	15.3	4 x Graphite	0.475	– 5 to + 80	1 to 2,000	Plastic shaft, fixed cable 3 m
285106037	LF 513 T	120	12	2 Pt rings	1.0	– 5 to + 80	1 to 200	Plastic shaft, 1 m cable
285106131	LF 613 T	120	12	4 Pt rings	1.0	– 5 to + 80	1 to 2,000	Plastic shaft, 1 m cable
285106189	LF 713 T	120	12	4 Pt rings	1.0	– 30 to + 135	1 to 2,000	Glass shaft, 1 m cable
285106190	LF 713 T-250	250	12	4 Pt rings	1.0	– 30 to + 135	1 to 2,000	Glass shaft, 1 m cable
285106250	LF 813 T	120	12	5 Pt rings	0.650	– 5 to + 80	1 to 2,000	Plastic shaft, 1 m cable
285106260	LF 913 T	120	12	5 Pt rings	0.650	– 30 to + 135	1 to 2,000	Glass shaft, 1 m cable
285130320	LF 913 T-ID	120	12	5 Pt rings	0.650	– 30 to + 135	1 to 2,000	glass shaft, 1 m cable, ID function
285104630	LFOX 1400	145	15.3	Graphite	0.475	0 to + 50	1 to 2,000	Combined 4-pole conductivity cell and galvanic D.O. sensor LFOX 1400 ID, plastic shaft, fixed cable 3 m
285130330	LFOX 1400 ID	145	15.3	Graphite	0.475	0 to + 50	1 to 2,000	Combined 4-pole conductivity cell and galvanic D.O. sensor LFOX 1400 ID, plastic shaft, fixed cable 3 m, ID function

[1)] Outside the recommended ranges measuring errors > 10 % can occur with these conductivity measuring cells.

ScienceLine conductivity measuring cells with plug head

Conductivity measuring cells with plug head

Shaft: 12 mm Ø

LF 1100+ | LF 1100T+ | LF 4100+ | LF 5100+ *LF 5100T+*

Order No.	Type No.	Length L [mm]	Ø [mm]	Sensor	Cell const. ~ [cm^{-1}]	Temp. range [°C]	Meas. range[1] [µS/cm] to [mS/cm]	Remarks
1069976	LF 1100+	120	12	2 Pt plates	1.0	–30 to 135	1 to 200	SMEK plug head
1069977	LF 1100T+	120	12	2 Pt plates	1.0	–30 to 135	1 to 200	SMEK plug head
1069978	LF 4100+	100	12	2 Pt plates	1.0	–30 to 135	1 to 200	SMEK plug head, flow-through cell
1069979	LF 5100+	120	12	2 Pt rings	1.0	–5 to 80	1 to 200	SMEK plug head, plastic shaft
1069990	LF 5100T+	120	12	2 Pt rings	1.0	–5 to 80	1 to 200	SMEK plug head, plastic shaft

[1] Outside the recommended ranges measuring errors > 10 % can occur with these conductivity measuring cells.

ScienceLine sensors for ammonia, sodium, oxygen, ion-selective indicator electrodes

Ammonia combination electrode with plug head

Shaft material: plastic, 12 mm Ø
Connection cable: e.g. L 1 A

Sodium combination electrode with plug head

Reference system: Silamid®
Shaft material: glass, 12 mm Ø
Zero point: pNa = 2.0
Membrane shape: sphere
Connection cable: e.g. L 1 A

Oxygen electrodes

Shaft material: plastic (POM)

ISE measuring cells

Shaft material: plastic
Length: 120 mm
Fixed cable: 1 m long, with DIN plug

ISE combination electrodes with plug head

Shaft material: plastic
Length: 120 mm

NH 1100

Na 61

OX 1100+

9009/61

Cu 1100 A
Ca 1100 A
F 1100 A
Pb 1100 A

F 60
Cl 60
NO 60
K 60
CA 60
CN 60
AG-S 60
I 60
BR 60
CU 60
PB 60

Order No.	Type No.	Length L [mm]	Temp. range [°C]	Meas. range [mg/l]	Remarks
285102808	NH 1100	120	0 to + 50	0.1 to 1,000	membrane module replaceable

Order No.	Type No.	Length L [mm]	Junction	Membrane Glass	Temp. range [°C]	Meas. range [pNa]	Remarks
285100026	Na 61	170	platinum	Na	-10 to +80	0 to 6	electrolyte KCl 3 mol/l, aqueous solution NaCl 0.1 mol/l

Order No.	Type No.	Length L [mm]	Temp. range [°C]	Meas. range [mg/l]	Remarks
1069975	OX 1100+	120	0 to + 45	0 to 60	galvanic sensor, Pt cathode, Ag anode, SMEK plug head, temperature compensated (NTC 100kW), shaft 12 mm Ø, measuring current at saturation ~100 nA, minimum flow rate 10 cm/s, connection cable e.g. LS 1 ST4 OX (for CG 867)
285111664	9009/61	145	0 to + 50	0 to 50	amperometric sensor, Au cathode, Pb anode, fixed cable 1.5 m[1] with 8-pole plug, IMT temperature compensation, shaft 15.25 mm Ø, membrane FEP, 13 µm thick, accuracy 1% at 18 cm/s flow rate.

Order No.	Type No.	Parameter	Temp. range [°C]	pH-range	Measuring range [mg/l]
285216314	Ca 1100 A	Calcium	0 to + 40	2.5 to 11	0.02 to 40,000
285216312	Cu 1100 A	Copper	0 to + 80	2 to 6	0.0006 to 6,400
285216313	F 1100 A	Fluoride	0 to + 80	5 to 7	0.02 to saturated
285216315	Pb 1100 A	Lead	0 to + 80	4 to 7	0.1 to 20,000

Order No.	Type No.	Parameter	Temp. range [°C]	pH-range	Measuring range [mg/l]
285130340	F 60	Fluoride	0 to + 80	5 to 7	0.02 to saturated
285130350	Cl 60	Chloride	0 to + 80	2 to 12	2 to 35,000
285130360	NO 60	Nitrate	0 to + 40	2.5 to 11	0.4 to 62,000
285130370	K 60	Potassium	0 to + 40	2 to 12	0.04 to 39,000
285130380	CA 60	Calcium	0 to + 40	2.5 to 11	0.02 to 40,000
285130390	CN 60	Cyanide	0 to + 80	0 to 14	0.2 to 260
285130400	AG-S 60	Sulfide / silver	0 to + 80	2 to 12	0.003 to 32,000 / 0,01 to 108.000
285130410	I 60	Iodide	0 to + 80	0 to 14	0.006 to 127,000
285130420	BR 60	Bromide	0 to + 80	1 to 12	0.4 to 79,000
285130430	CU 60	Copper	0 to + 80	2 to 6	0.0006 to 6400
285130440	PB 60	Lead	0 to + 80	4 to 7	0.2 to 20,000

[1] Other cable lengths available on request

Resistance thermometers

Resistance thermometers
with SMEK plug head

Resistance thermometers
with 1 m fixed cable

Resistance thermometer
with coaxial plug head

W 2030+
W 2130+

W 5780 NN

W 5790 NN
W 5790 PP
W 5791 NN

W 5980 NN

W 2180-KOAX

Resistance thermometers with SMEK plug head

Order No.	Type No.	Length L [mm]	Ø [mm]	Sensor	Temp. range [°C]	Shaft material	Connection cable e.g.
1069991	W 2030 +	120	12	Pt 100	-30 to + 135	glass	LS 1 N6
1069992	W 2130 +	120	12	Pt 1,000	-30 to + 135	glass	LS 1 N6

Resistance thermometers with 1 m fixed cable

Order No.	Type No.	Lenght L [mm]	Ø [mm]	Sensor	Temp. range [°C]	Shaft material	Connection plug
285105221	W 5780 NN	120	6	Pt 1,000	- 30 to + 135	glass	2 x 4 mm Ø
285105254	W 5790 NN	120	4	Pt 1,000	- 30 to + 135	stainless steel	2 x 4 mm Ø
285105776	W 5790 PP	120	4	Pt 1,000	- 30 to + 135	stainless steel	2 x 4 mm Ø
285105262	W 5791 NN	170	4	Pt 1,000	- 30 to + 135	stainless steel	2 x 4 mm Ø
285105287	W 5980 NN	96[1)]	5 NS 7.5	Pt 1,000	- 30 to + 135	glass	2 x 4 mm Ø

Resistance thermometer with coaxial plug head

Order No.	Type No.	Length L [mm]	Ø [mm]	Sensor	Temp. range [°C]	Shaft material
285119030	W 2180-KOAX	120	12	Pt 1,000	- 30 to + 135	glass

[1)] length from upper end of standard taper

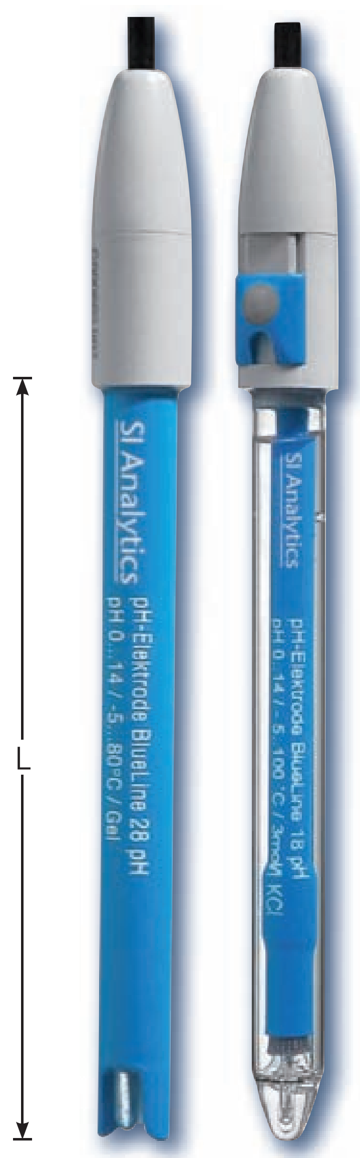
BlueLine pH combination electrodes

The robust electrodes for general applications

pH range	0 to 14
Temperature range	-5 to +80 °C
Shaft	Noryl, 12 mm Ø
Shaft length L	120 mm
Zero point	pH = 7.0 ± 0.3
Junction	fibr e
Reference system	Ag / AgCl
Reference electrolyte	gel (KCl), low maintenance, not refillable
Shape of glass membrane	cylindrical
Resistance of glass membrane (25 °C)	400 MΩ
Type of membrane glass	A

The liquid electrolyte electrodes for demanding measurements

pH range	0 to 14
Temperature range	-5 to +100 °C
Shaft	glass, 12 mm Ø
Shaft length L L	120 mm
Zero point	pH = 7.0 ± 0.3
Junction	platinum
Reference system	Ag / AgCl
Reference electrolyte	KCl 3 mol/l
Shape of glass membrane	conical
Resistance of glass membrane (25 °C)	200 MΩ
Type of membrane glass	A



BlueLine
28 pH
22 pH
23 pH
23-2 pH
23-5 pH-S
24 pH
24-3 pH
25 pH
25-2 pH
25-5 pH
26 pH
26 pH-Cinch
28 pH-P
28-5 pH
29 pH
29 pH-P

BlueLine
18 pH
11 pH
12 pH
14 pH
14 pH ID
15 pH
15 pH ID
15 pH Cinch
17 pH
17 pH-R
19 pH

Order No.	BlueLine Type No.	Temperature sensor integrated	Connection
285129225	22 pH	no	plug head, recommended cable: e.g. LB1A
285129233	23 pH	no	1 m fixed cable with DIN plug 19 262
1063462	23-2 pH	no	2 m fixed cable with DIN plug
1066411	23-5 pH-S	no	5 m fixed cable with S plug
285129241	24 pH	NTC 30 kΩ	1 m fixed cable with DIN plug 19 262 + banana plug
285129533	24-3 pH	NTC 30 kΩ	3 m fixed cable with DIN plug 19 262 + banana plug
285129258	25 pH	no	1 m fixed cable with BNC plug
1063461	25-2 pH	no	2 m fixed cable with BNC plug
285129540	25-5 pH	no	5 m fixed cable with BNC plug
285129266	26 pH	NTC 30 kΩ	1 m fixed cable with BNC plug + banana plug
285095712	26 pH-Cinch	NTC 30 kΩ	1 m fixed cable with BNC plug + cinch plug
285129282	28 pH	Pt 1,000	1 m fixed cable with DIN plug 19 262 + banana plug
1065896	28 pH-P	Pt 1,000	1 m fixed cable with DIN plug 19 262 + 2-mm pole plug
285129570	28-5 pH	Pt 1,000	5 m fixed cable with DIN plug 19 262 + banana plug
1065895	29 pH	Pt 1,000	1 m fixed cable with BNC plug + banana plug
1065894	29 pH-P	Pt 1,000	1 m fixed cable with BNC plug + 2-mm pole plug

Order No.	BlueLine Type No.	Temperature sensor integrated	Connection
285129114	11 pH	no	plug head, recommended cable: e.g. LB1A
285129122	12 pH	no	1 m fixed cable with DIN plug 19 262
285129147	14 pH	NTC 30 kΩ	1 m fixed cable with DIN plug 19 262 + banana plug
285129440	14 pH ID	NTC 30 kΩ	1 m fixed cable with DIN plug + 4-mm banana plug, ID function
285129155	15 pH	NTC 30 kΩ	1 m fixed cable with BNC plug + banana plug
285129450	15 pH ID	NTC 30 kΩ	1 m fixed cable with BNC plug + 4-mm banana plug, ID function
285095730	15 pH Cinch	NTC 30 kΩ	1 m fixed cable with BNC plug + cinch plug
285129171	17 pH	no	1 m fixed cable with BNC plug
1064746	17 pH-R	no	1 m fixed cable with Metrohm plug
285129188	18 pH	Pt 1,000	1 m fixed cable with DIN plug 19 262 + banana plug
285129190	19 pH	Pt 1,000	1 m fixed cable with BNC plug + banana plug

BlueLine
Special sensors

The specialists
for special applications

Zero point of
pH electrodes
pH = 7.0 ± 0.3

Connection cable
for pH/Redox
electrodes
e.g. LB 1 A

BlueLine
13 pH

BlueLine
16 pH

BlueLine
21 pH

21 pH 1M
DIN ID

21 pH 1M
BNC ID

BlueLine
27 pH

27 pH 1M
DIN ID

27 pH 1M
BNC ID

BlueLine
54 pH

BlueLine 56
pH

BlueLine 56
pH Cinch

BlueLine
31 Rx

BlueLine
32 Rx

BlueLine
48 LF

BlueLine

Precision electrode
BlueLine 13 pH
Glass shaft, screw ground joint junction, electrolyte KCl 3 mol/l, Ag/AgCl reference system, spherical membrane, A-glass, plug head, length 170 mm, 12 mm Ø, –5 to +100 °C, 0 to 14 pH, Order No. 285129139

Micro electrode
BlueLine 16 pH
Glass shaft, platinum junction, electrolyte KCl 3 mol/l, Ag/AgCl reference system, spherical membrane, A-glass, plug head, length 40/80 mm, 12/5 mm Ø, –5 to +100 °C, 0 to 14 pH, Order No. 285129163

Spear tip electrode
BlueLine 21 pH
Glass shaft, hole junction, Referid® electrolyte, Ag/AgCl reference system, Spear membrane, A-glass, plug head, length 65/25 mm, 12/5 mm Ø, –5 to +80 °C, 2 to 13 pH, Order No. 285129217

Spear tip electrode
with sensor recognition
BlueLine 21 pH 1M-DIN-ID
Like BlueLine 21 pH but with 1 m fixed cable with DIN plug and sensor recognition
Order No. 285129930

Spear tip electrode
with sensor recognition
BlueLine 21 pH 1M-BNC-ID
Like BlueLine 21 pH but with 1 m fixed cable with BNC plug and sensor recognition
Order No. 285129940

Surface electrode
BlueLine 27 pH
Glass shaft, KPG® annular gap junction, Referid® electrolyte, Ag/AgCl reference system, flat membrane, A-glass, plug head, length 120 mm, 12 mm Ø, –5 to +50 °C, 2 to 13 pH, Order No. 285129274

Surface electrode
with sensor recognition
BlueLine 27 pH 1M-DIN-ID
Like BlueLine 27 pH but with 1 m fixed cable with DIN plug and sensor recognition
Order No. 285129950

Surface electrode
with sensor recognition
BlueLine 27 pH 1M-BNC-ID
Like BlueLine 27 pH but with 1 m fixed cable with BNC plug and sensor recognition
Order No. 285129960

Combination electrode
with plastic shaft
BlueLine 54 pH
Ceramic junction, electrolyte KCl 3 mol/l, Ag/AgCl-reference system, temp.-sensor NTC 30 kΩ, cylinder membrane, A glass, 1 m fixed cable with BNC- +4-mm banana plug, length 120 mm, 12 mm Ø, –5 to +80 °C, 0 to 14 pH
Order No. 285129460

Combination electrode
with plastic shaft
BlueLine 56 pH
Like BlueLine 54 pH but with BNC plug
Order No. 285129640

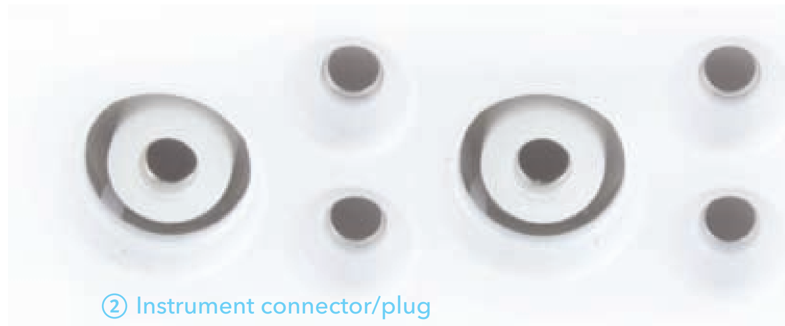
Combination electrode
with plactic shaft
Blueline 56 pH cinch
Like BlueLine 54 pH but with BNC and cinch plug
Order No. 285129650

Redox electrode
BlueLine 31 Rx
Glass shaft, ceramic junction, electrolyte KCl 3 mol/l, Ag/AgCl reference system, sensor platinum disk 4 mm Ø, plug head, length 120 mm, 12 mm Ø, –5 to +100 °C, Order No. 285129311

Redox electrode
BlueLine 32 Rx
Plastic shaft, fiber junction, gel electrolyte, Ag/AgCl reference system, sensor platinum pin 1 mm Ø, plug head, length 120 mm, 12 mm Ø, –5 to +80 °C, Order No. 285129320

Conductivity cell
for low ionic media
BlueLine 48 LF
Stainless steel shaft, 2-pin cell, 1 m fixed cable with 8-pole plug, sensor stainless steel, cell constant 0.1 cm–1, temperature sensor NTC 30 kΩ, length 120 mm, 12 mm Ø, –5 to +100 °C, measuring range 0 to 300 µS/cm, Order No. 285129488

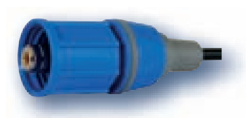
Connection cables



① Electrode socket/plug

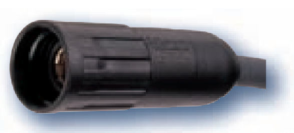
Coaxial plug for pH, redox, ammonia and sodium combination electrodes, pH and redox single electrodes as well as reference electrodes in *Plus* series. The L and LB series plugs are compatible. The LB sockets are matching colors with the BlueLine electrodes.

plug L
plug LB



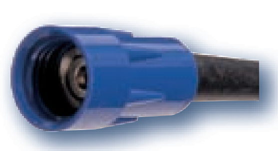
SMEK plug for pH combination electrodes with temperature sensor as well as conductivity measuring cells, resistance thermometers and oxygen sensors from Plus series

plug LS



Electrode plug for reference electrodes from the predecessor series, i.e. "*non-Plus*" versions

plug B

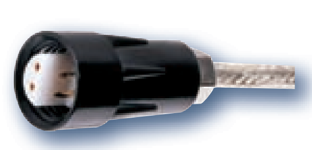


Plug for resistance thermometers in conductivity measuring cells without temperature sensor, for older models

plug 9 907/00

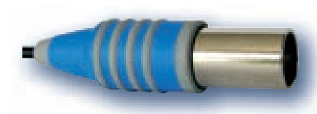
Plug for conductivity measuring cells with temperature sensor and oxygen cells, for older models

plug 9 909/00

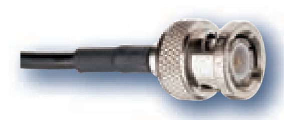


② Instrument connector/plug

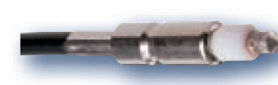
A (DIN 19 262)



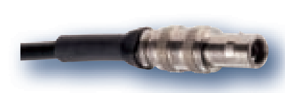
BNC



EE (Radiometer)

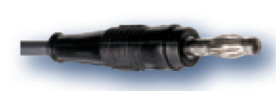


R (Metrohm)



S (UK socket without extension)

N (4-mm banana plug)



P (2-mm pole plug)

8-pole (for Handylab and Lab and ProLab conductometer)

9910/00

Not illustrated:

X (without instrument plug, meaning free cable end)

The connecting cables are available in various combinations of electrode socket, instrument plug and cable length. Should you i.e. require a coaxial cable for connecting a pH electrode to a meter, please select i.e.a cable type L 1 A. The "L" as part of the type description stands for the coaxial plug (please refer to page 86) of the electrode, the middle number stands for the cable length and the "A" for the instrument connection (in this example for a DIN plug).

In case you do not find your desired cable combination listed below, please contact us.

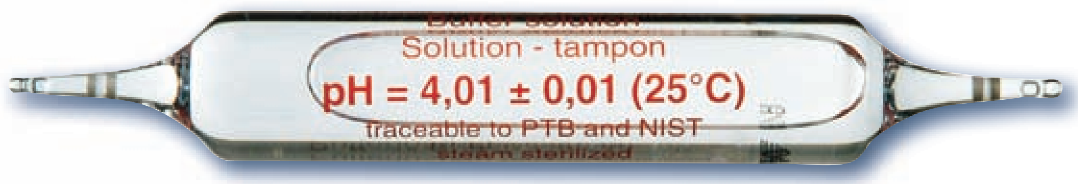
Order No.	Type No.	① Electrode socket/plug	② Instrument connector/plug	Cable length and type
285122904	A 1 A	DIN instrument plug (A)	DIN instrument plug (A)	1 m coax. cable
285123793	A 1 BNC	DIN instrument plug (A)	BNC instrument plug	1 m coax. cable
285121916	B 1 N	reference electrode plug (B)	4 mm banana plug (N)	1 m single conductor cable
285122012	B 1 P	reference electrode plug (B)	2 mm Pole plug (P)	1 m single conductor cable
285121813	B 1 X	reference electrode plug (B)	free end (X)	1 m single conductor cable
285122456	L 1 A	electrode plug (L)	DIN instrument plug (A)	1 m coax. cable
285122497	L 1 BNC	electrode plug (L)	BNC instrument plug	1 m coax. cable
285122501	L 1 EE	electrode plug (L)	Radiometer instrument plug (EE)	1 m coax. cable
285122457	L 1 N	electrode plug (L)	4 mm banana plug (N)	1 m coax. cable
285122489	L 1 NN	electrode plug (L)	2 x 4 mm banana plug (N)	1 m coax. cable
285122534	L 1 R	electrode plug (L)	Metrohm instrument plug (R)	1 m coax. cable
285122407	L 1 X	electrode plug (L)	free end (X)	1 m coax. cable
285122464	L 2 A	electrode plug (L)	DIN instrument plug (A)	2 m coax. cable
285122448	L 2 NN	electrode plug (L)	2 x 4 mm banana plug (N)	2 m coax. cable
285122653	LB 1 A	electrode plug (LB)	DIN instrument plug (A)	1 m coax. cable
285122661	LB 1 BNC	electrode plug (LB)	BNC instrument plug	1 m coax. cable
285122678	LB 3 A	electrode plug (LB)	DIN instrument plug (A)	3 m coax. cable
285122707	LS 1 ANN	SMEK electrode plug	DIN (A) + 2 x 4 mm banana plug (N)	1 m cable KA19
285122715	LS 3 ANN	SMEK electrode plug	DIN (A) + 2 x 4 mm banana plug (N)	3 m cable KA19
285122723	LS 1 BNCNN	SMEK electrode plug	BNC + 2 x 4 mm banana plug (N)	1 m cable KA19
285122731	LS 3 BNCNN	SMEK electrode plug	BNC + 2 x 4 mm banana plug (N)	3 m cable KA19
1066726	LS 1 D8	SMEK electrode plug	8-pole instrument plug	1 m cable
1066728	LS 1 N6	SMEK electrode plug	6 x 4 mm banana plug (N)	1 m cable KA09
285122756	LS 1 RNN	SMEK electrode plug	Metrohm (R) + 2 x 4 mm banana plug (N)	1 m cable KA19
1069104	LS 1 ST4LF	SMEK electrode plug	4-pole incremental plug	1 m cable
1066727	LS 1 ST4OX	SMEK electrode plug	4-pole incremental plug	1 m cable KA10
285124716	9907/21	electrode plug (9907/00)	2 x 4-mm plug (N) for LF cells	1 m two-conductor cable
285125618	9909/31	electrode plug (9907/00)	2 x 4-mm plug (N)	1 m two-conductor cable
285125515	9910/11	electrode plug (9909/00)	9910	1 m four-conductor cable
285125215	9910/21	electrode plug (9909/00)	9910	1 m four-conductor cable, shielded
285125523	9919/21	electrode plug (9907/00)	8-pole instrument plug	1 m two-conductor cable
285125548	9919/41	electrode plug (9909/00)	8-pole instrument plug	1 m four-conductor cable

Cables

Other plug/cable combinations available on request

Solutions

Buffer solutions in the unique double-end ampoules offer a particularly high degree of reliability and measuring accuracy.



The exactness of the pH measurement is mainly dependent on the accuracy of calibration. This again highly depends on the reliability of the buffer.

Hermetically sealed in the glass ampoule and sterilized with hot steam, same as a pharmaceutical product, the buffer solutions free of preservation agent have an extremely long shelf life and guarantee continuously error-free characteristics.

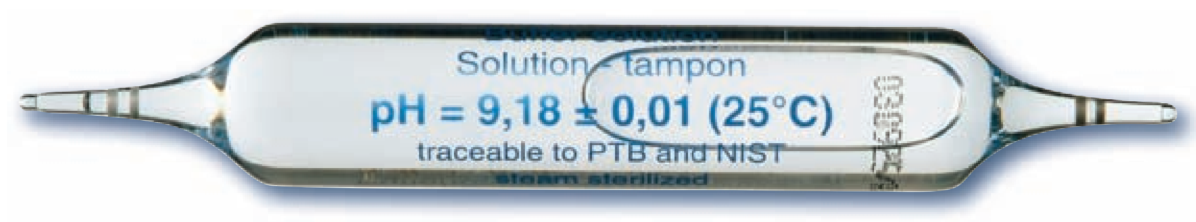
The ampoules can be easily opened at the breaking point. Tools are not required. Since refilling is not possible, you are always ensured of maximum calibration reliability.

Standard buffer solutions according to DIN 19 266
Hot steam sterilized for longer stability, no preservation agents used.

Order No.	Type No.	pH value at 25 °C	Contents
285137977	L 4791	1.68	60 FIOLAX® ampoules à 20 ml*, with manufacturer's certificate
285138246	L 4794	4.01	60 FIOLAX® ampoules à 20 ml*, with manufacturer's certificate
285138254	L 4796	6.87	60 FIOLAX® ampoules à 20 ml*, with manufacturer's certificate
285138262	L 4799	9.18	60 FIOLAX® ampoules à 20 ml*, with manufacturer's certificate
285138402	L 4790	4.01 / 6.87	2 x 30 FIOLAX® ampoules à 20 ml*, with manufacturer's certificate
285137985	L 4797	1.68 / 6.87 / 9.18	3 x 20 FIOLAX® ampoules à 20 ml*, with manufacturer's certificate
285138238	L 4798	4.01 / 6.87 / 9.18	3 x 20 FIOLAX® ampoules à 20 ml*, with manufacturer's certificate
285138279	L 4893 / Set	4.01 / 6.87	2 x 9 FIOLAX® ampoules à 20 ml*, with manufacturer's certificate, with electrolyte solution L 3008

Order No.	Type No.	pH value at 25 °C	Contents
285137841	L 168	1.68	1,000 ml in DURAN® glass bottle, with manufacturer's certificate
285137677	L 1684	1.68	250 ml in DURAN® glass bottle, with manufacturer's certificate
285138098	L 401	4.01	1,000 ml in DURAN® glass bottle, with manufacturer's certificate
285138008	L 4014	4.01	250 ml in DURAN® glass bottle, with manufacturer's certificate
285138102	L 687	6.87	1,000 ml in DURAN® glass bottle, with manufacturer's certificate
285138016	L 6874	6.87	250 ml in DURAN® glass bottle, with manufacturer's certificate
285138119	L 918	9.18	1,000 ml in DURAN® glass bottle, with manufacturer's certificate
285138024	L 9184	9.18	250 ml in DURAN® glass bottle, with manufacturer's certificate

* 20 ml volume = ~17 ml content



- Highest measurement reliability
- Extremely long storage times, thanks to hot-steam sterilization
- No preservative agents
- Maximize calibration reliability

Advantages FIOLAX®

Technical buffer solutions
Hot steam sterilized for longer stability, no preservation agents used.

Order No.	Type No.	pH value at 25 °C	Contents
285138213	L 4694	4.00	60 FIOLAX® ampoules à 20 ml*, with manufacturer's certificate
285138221	L 4697	7.00	60 FIOLAX® ampoules à 20 ml*, with manufacturer's certificate
285138205	L 4691	10.01	60 FIOLAX® ampoules à 20 ml*, with manufacturer's certificate
285138398	L 4690	4.00 / 7.00	2 x 30 FIOLAX® ampoules à 20 ml*, with manufacturer's certificate
285138192	L 4698	4.00 / 7.00 / 10.01	3 x 20 FIOLAX® ampoules à 20 ml*, with manufacturer's certificate
285138632	L 4895 / Set	4.00 / 7.00	2 x 9 FIOLAX® ampoules à 20 ml*, with manufacturer's certificate, with electrolyte solution L 3008,

Order No.	Type No.	pH value at 25 °C	Contents
285138727	L 400	4.00	1,000 ml in DURAN® glass bottle, with manufacturer's certificate
285138032	L 4004	4.00	250 ml in DURAN® glass bottle, with manufacturer's certificate
285138735	L 700	7.00	1,000 ml in DURAN® glass bottle, with manufacturer's certificate
285138049	L 7004	7.00	250 ml in DURAN® glass bottle, with manufacturer's certificate
285138719	L 100	10.01	1,000 ml in DURAN® glass bottle, with manufacturer's certificate
285138057	L 1004	10.01	250 ml in DURAN® glass bottle, with manufacturer's certificate

* 20 ml volume = ~17 ml content

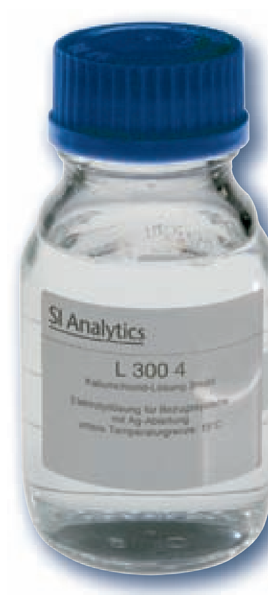
Solutions

Color-coded technical buffer solutions in plastic bottles

Order No.	Type No.	pH value at 25 °C	Contents
285139156	LC 4004 K	4.01	250 ml in PE bottle
285139189	LC 7004 K	7.00	250 ml in PE bottle
285139218	LC 1004 K	10.01	250 ml in PE bottle

Electrolyte solutions, aqueous
for reference electrodes, as electrolyte bridges and for storage

Order No.	Type No.	Description	Contents
285136956	L 101	potassium chloride solution 1 mol/l	1,000 ml in DURAN® glass bottle, sterilized
285138649	L 1254	potassium sulfate solution 0.6 mol/l	250 ml in DURAN® glass bottle
285138151	L 200	low temperature electrolyte (–30 °C)	1,000 ml in DURAN® glass bottle
285138365	L 2004	low temperature electrolyte (–30 °C)	250 ml in DURAN® glass bottle
285138349	L 2114	2 mol/l KNO_3 + 0.001 mol/l KCl for Ag combination electrodes	250 ml in DURAN® glass bottle
285136923	L 2214	2 mol/l KNO_3 + 0.001 mol/l KCl for Ag combination electrodes, thickened	250 ml in DURAN® glass bottle
285138332	L 2224	potassium chloride solution 2 mol/l	250 ml in DURAN® glass bottle
285138554	L 300	potassium chloride solution 3 mol/l	1,000 ml in DURAN® glass bottle, sterilized
285138427	L 3004	potassium chloride solution 3 mol/l	250 ml in DURAN® glass bottle, sterilized
285138505	L 3008	potassium chloride solution 3 mol/l	50 ml in PE bottle
285138419	L 3014	potassium chloride solution 3 mol/l, Ag/AgCl saturated	250 ml in DURAN® glass bottle
285138468	L 310	potassium chloride solution 2 mol/l, gel for sterilizable electrodes	1,000 ml in DURAN® glass bottle
285138484	L 3104	potassium chloride solution 2 mol/l, gel for sterilizable electrodes	250 ml in DURAN® glass bottle
285138702	L 320 K	potassium chloride solution 2 mol/l, gel for Ag_2S electrodes	1,000 ml in DURAN® glass bottle
285138143	L 350	potassium chloride solution 3.5 mol/l	1,000 ml in DURAN® glass bottle, sterilized
285138127	L 3504	potassium chloride solution 3.5 mol/l	250 ml in DURAN® glass bottle, sterilized
285138587	L 420	potassium chloride solution 4.2 mol/l	1,000 ml in DURAN® glass bottle
285138608	L 4204	potassium chloride solution 4.2 mol/l	250 ml in DURAN® glass bottle
285138590	L 911	storage electrolyte solution, sterilized	1,000 ml in DURAN® glass bottle
285138560	L 9114	storage electrolyte solution, sterilized	250 ml in DURAN® glass bottle



Solutions

Electrolyte solutions, organic
for measurements in organic solutions for reference electrodes and as electrolyte bridges

Order No.	Type No.	Description	Contents
285138324	L 5014	LiCl saturated in glacial acetic acid	250 ml in DURAN® glass bottle
285138308	L 5034	LiCl 1,5 mol/l in ethanol	250 ml in DURAN® glass bottle

Solutions for oxygen measurements

Order No.	Type No.	Description	Contents
285138513	L 6708	electrolyte for oxygen electrodes OX 1100 / OX 1100 + / OX 1101	50 ml in PE bottle
285126606	OX 920	electrolyte for oxygen electrodes 9009 / 61	50 ml in PE bottle
285126614	OX 921	cleaning solution for oxygen electrodes 9009 / 61	30 ml in PE bottle
285138287	OX 060	zero point solution for oxygen electrodes OX 1100 / OX 1100 +	60 FIOLAX® ampoules à 20 ml volume = ~17 ml content

Solutions for ammonia measurements

Order No.	Type No.	Description	Contents
285137344	L 6408	electrolyte for ammonia combination electrodes	50 ml in PE bottle

Solutions for ISE electrodes

Order No.	Type No.	Description	Contents
106575	ELY / BR / 503	Bridge electrolyte, general (except potassium and nitrate)	250 ml
106577	ELY / BR / 503 / K	Bridge electrolyte for potassium	250 ml
106576	ELY / BR / 503 / N	Bridge electrolyte for nitrate	250 ml
120120	ES / Br	Standard solution conc. 10 g/l bromide	1,000 ml
120200	ES / Ca	Standard solution conc. 10 g/l calcium	1,000 ml
120140	ES / CL	Standard solution conc. 10 g/l chloride	1,000 ml
120190	ES / Cu	Standard solution conc. 10 g/l copper	1,000 ml
120160	ES / F	Standard solution conc. 10 g/l flouride	1,000 ml
120180	ES / I	Standard solution conc. 10 g/l iodide	1,000 ml
120210	ES / K	Standard solution conc. 10 g/l iodide	1,000 ml
120220	ES / NO_3	Standard solution conc. 10 g/l nitrate	1,000 ml
120100	ES / Pb	Standard solution conc. 10 g/l lead	1,000 ml
140120	ISA / Ca	Ionic strength adjustment solution for calcium	250 ml
140110	ISA / FK	250 ml Ionic strength adjustment solution for Pb^{2+}, Br^-, Cl^-, I^-, Cu^{2+}, SCN^-, Cd^{2+}	250 ml
106580	ISA / K	Ionic strength adjustment solution for K^+	250 ml
150130	MZ / NH_3 / CN	Alkaline solution for the adjustment of the ionic strength for the CN^- electrode	250 ml
140100	TISAB	Ionic strength adjustment solution for F^-	4 x 1,000 ml
150120	TISAB / NO_3	Ionic strength adjustment solution for nitrate	4 x 1,000 ml

Solutions

Solutions and accessories for conductivity measurements

Order No.	Type No.	Description	Contents
285126503	LF 990	test solution KCl 0.001 mol/l (147 µS/cm)	3 x 6 FIOLAX® ampoules à 20 ml*, with manufacturer certificate
285126511	LF 991	test solution KCl 0.01 mol/l (1.41 mS/cm)	3 x 6 FIOLAX® ampoules à 20 ml*, with manufacturer certificate
285126528	LF 992	test solution KCl 0.1 mol/l (12.9 mS/cm)	3 x 6 FIOLAX® ampoules à 20 ml*, with manufacturer certificate
285126293	LF 995	test solutions KCl 0.01 / 0.1 / 1 mol/l (1.41 / 12.9 / 112 mS/cm)	3 x 6 FIOLAX® ampoules à 20 ml*, with manufacturer certificate
285126166	LF 1000 / Set	same as LF 999 / set, in addition platinizing vessel and cable B 1 N	3 x 6 FIOLAX® ampoules à 20 ml*, with manufacturer certificate
285136907	LF 1024	test solution KCl 0.01 mol/l (1.41 mS/cm)	250 ml in PE bottle
285126530	LF CSKC13	test solution KCl 1.3 µS/cm (maximum shelf life: unopened three months, opened six hours)	250 ml in PE bottle
285126540	LF CSKC5	test solution KCl 5.0 µS/cm, (maximum shelf life: six months)	500 ml in PE bottle

Accessories for electrodes

Order No.	Type No.	Redox voltage Pt/Calomel (KCl sat.)	Pt/Ag/AgCl (KCl 3 mol/l)	Contents
285138373	L 4619	180 mV	220 mV	60 FIOLAX® ampoules à 20 ml*, acc. to DIN 38 404-C6
285138357	L 4643	430 mV	470 mV	60 FIOLAX® ampoules à 20 ml*,
285138381	L 4660	600 mV	640 mV	60 FIOLAX® ampoules à 20 ml*
285138784	L 4648	180, 430, 600 mV	220, 470, 640 mV	3 x 20 FIOLAX® ampoules à 20 ml*
285138184	L 430	430 mV	470 mV	1,000 ml in DURAN® glass bottle
285138168	L 4304	430 mV	470 mV	250 ml in DURAN® glass bottle

Cleaning solutions for combination electrodes and reference electrodes

Order No.	Type No.	Description	Contents
285138538	L 510	pepsin / hydrochloric acid solution	1,000 ml in DURAN® glass bottle
285138295	L 5104	pepsin / hydrochloric acid solution	250 ml in DURAN® glass bottle

* 20 ml volume = ~17 ml content

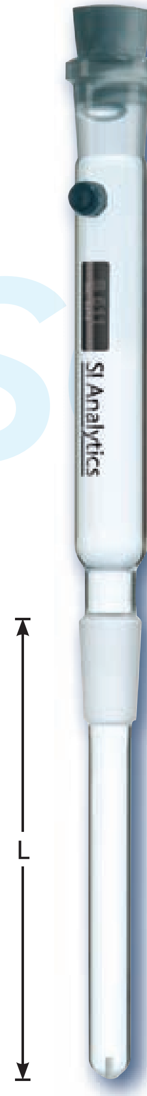
Electrolyte bridges, other accessories

Electrolyte bridges

Shaft: glass, 12 mm Ø

Order No.	Type No.	Length L [mm]	Junction	Description
285104209	B 511	103 [1)]	ceramic	standard taper NS 14.5 and sleeve NS 14.5 for electrode installation
285104217	B 521	120	ceramic	plastic sleeve and sleeve NS 14.5 for electrode installation
285104225	B 522	120	Pt lateral	plastic sleeve and sleeve NS 14.5 for electrode installation
285104233	B 524	120	ground joint	plastic sleeve and sleeve NS 14.5 for electrode installation

[1)] Length from upper end of standard taper



B 511

Z 451
Z 461

Z 462

Accessories for electrodes

Order No.	Type No.	Description
285123806	BXX	plug for reference electrodes, single pole
285123703	KXX	coaxial plug for combination electrodes and indicator electrodes
285126482	NH 928	electrolyte for ammonia electrodes in 50 ml plastic bottle, 3 membrane modules
285126499	NH 995	membrane module set: 3 membrane modules, 3 caps
285126639	OX 923	3 spare membrane heads for oxygen electrodes 9009/61
285126655	OX 925	maintenance set (OX 920, OX 921, OX 923 and SF 300) for oxygen electrodes 9009/61
285126277	OX 929	5 spare membrane heads for oxygen electrodes OX 1100/OX 1100+/OX 1101
285126647	OxiCal® SL	calibrating vessel for oxygen electrodes 9009/61
285126622	SF 300	grinding foil for oxygen electrodes 9009/61
285123728	SXX	coaxial plug for extension cable and for UK socket
285215229	TZ 1520	taper adapter NS 14.5 of PTFE for electrodes with Ø 12 mm shaft
285123103	Z 341	stainless steel clamp for NS 7.5/16
285123136	Z 451	measuring and storage vessel with sleeve NS 7.5/16
285123170	Z 453	electrode vessel for storing electrodes with Ø 12 mm shaft
285123152	Z 461	measuring and storage vessel with sleeve NS 14.5/23
285123169	Z 462	flow-through measuring vessel with sleeve NS 14.5/23
285123185	Z 472	watering cap for electrodes with Ø 12 mm shaft
285122961	Z 50	Knick electrode adapter
285123193	Z 501	O-Ring seal 10.5/1.5 for electrode plug head
285123214	Z 506	plug head sealing cap with male thread for KXX and BXX plugs
285129509	Z 512	plug head sealing cap with female thread for BlueLine electrodes

Z 453

Tips for succussful measurement with pH and redox electrodes

Content

Chapter 1: How are pH single-rod measuring cells constructed?

Problem

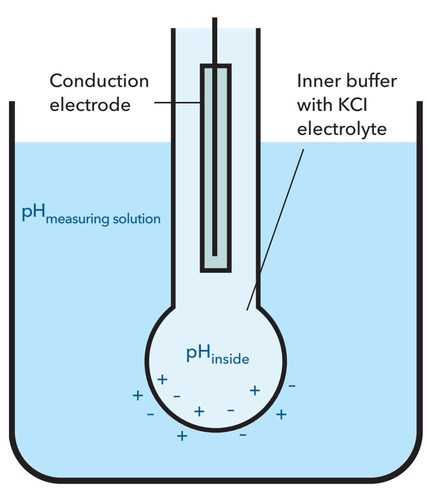
The users can select from a variety of different electrodes for the pH measurement. When first selecting, the selection is often the problem. It is therefore important to describe the components of the pH electrodes including their features, so that the best electrode can be found for the application.

Question

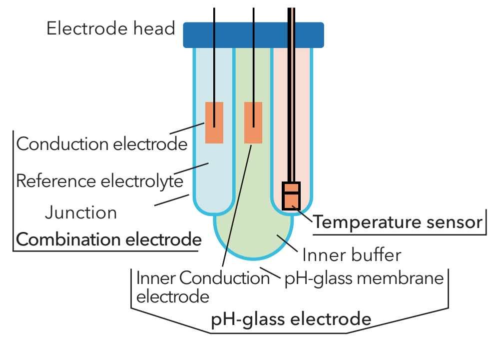
Which components make up a single-rod pH measuring cell and what functions do they have?

Answer

The basic structure of pH electrodes is very simple: As potentiometric measuring chains, they consist of a measuring electrode and a reference electrode. For many years, it has been the state of the art to integrate both in a shaft as single rod measuring cell. In addition, a large proportion of pH electrodes available on the market today have already an installed temperature sensor to automatically compensate the temperature dependence of the electrode slope in the pH meter. The construction of such pH-electrodes is described in DIN 19261 and clearly schematically shown in Figure 1 1.



2 *The processes on the junction of the single-rod measuring*



1 *Structure of a single rod measuring cell*

Why does the user need a reference electrode for the pH measurement?

The pH glass electrode is the measuring electrode. The pH signal is generated by it in mV, which is directly proportional to the pH value of the measurement solution. However, the measurement signal can only be measured against a reference electrode, since only differences in potential and therefore voltages can be measured. The reference electrode ideally has a stable, constant potential independent of the pH value and the composition of the medium at all temperatures.

What happens on the glass junction?

The glass junction changes due to the pH value 2. Under the effect of water, alkali ions dissolve from the glass surface and the oxide bridges of the silicate framework partially become OH-groups based on the absorption of water. This is how a "gel layer" develops. This gel layer acts on hydrogen ions as an ion exchanger.

How does the exchange process work?

In the special pH junction glasses, a reproducible balance develops between the solution and the glass surface, which only depends on the hydrogen ion concentration in the solution and in the gel layer.

Finally, the question remains, how the user recognizes the right choice of the measuring chain: The correct measurement chain provides the highest measurement reliability and longest service life in the application.

Conclusion

Only an electrode matching the application achieves the best measurement reliability and maximum service life. It is especially important to pay attention to the type of junction in the selection of the electrode. This is established by the connection between the electrode and the measuring medium. For example, the platinum junction, which provides a fast and stable measurement setting with its defined electrolyte flow and at the same time protects itself against the penetration of the measurement medium, is generally usable.

Chapter 2:
Reference systems of pH electrodes

Problem

Besides glass membranes and junctions, pH-electrodes differ in reference systems and junction types (junction). The desired application makes the choice between pH electrode reference systems and junctions easier.

Question

What is a pH electrode reference system and why do I need it? What kind of reference systems are there for pH electrodes and what features can they provide 3?

Answer

The most common method to obtain a pH measurement is by measuring a voltage. To measure a voltage the pH electrode must be able to measure the difference between two points with different electrical potential values. For a pH electrode to provide a voltage measurement of a solution's ion concentration a reference electrode is necessary because its potential essentially remains constant and independent of the solution and temperature relative to the solution being measured. The pH electrode can then use that reference electrode's potential to determine how the solution's ion concentration compares to the reference. The voltage developed from this comparison is then turned into the pH measurement.

The Standard Hydrogen Electrode (SHE) is used as the international reference system. Unfortunately due to its complicated handling requirements it is not typically used for standard applications. A common approved reference system is the Saturated calomel Electrode (SCE), however this electrode contains mercury and is toxic. The most common reference system is the silver/silver chloride reference system (Ag/AgCl). However, Ag/AgCl can precipitate silver when exposed to certain samples. An alternate configurations to the standard silver/silver chloride reference system is the double junction system. The double junction construction isolates the Ag/AgCl from the sample by means of a second chamber containg a simple electrolyte solution such as potassium chloride (KCl). A special type of double junction electrode is the Silamid double junction reference system which is a special construction of the Ag/AgCl reference system. Most electrodes having a Ag/AgCl system are built with an Ag wire coated with AgCl. Silamid reference systems have a glass tube with the inner part coated with Ag,

Reference System	Advantage	Disadvantage
Ag/AgCl	Well described, multifunctional, reproducible, wide temperature range, nontoxic ➔ environmental sustainability	Reference potential depends on temperature and could deliver a different potential, if measured at a different temperature as calibrated
Hg/Hg_2Cl_2 (Calomel)	Stable reference potential	Toxic, low temperature application range 59 to 104 °F (15 to 40 °C)
Tl,Hg/TlCl (Thalamide)	very low hysteresis, broad temperature range, low temperature coefficient	toxic, out of production
Iodine/Iodide	Low polarization, low temperature dependence, free of undesired heavy metal ions	formerly limited long-life-cycle

table 1 : Advantages and disadvantages of different reference systems

then filled with AgCl, and plugged with a polyester fibre. This reference system creates greater contact surface area between Ag and AgCl compared to the standard Ag/AgCl wire system. This results in a reference system that is long lasting and very stable. A more recent reference system is the iodine/iodide system. The iodine/iodide reference system does not precipitate silver and can be used with Tris buffers. The advantages and disadvantages of different reference systems are displayed in table 1. Further characteristics of the reference electrode are defined by the junction.

Conclusion

The most important pH electrode reference system is the Ag/AgCl system because it is well described, reproducible, and nontoxic. In the few applications where this reference system does have problems the newer iodine/iodide reference system can be used instead. Due to an absence of silver ions or other contaminating metal ions the iodine/iodide reference system is an excellent alternative when working with applications requiring rapidly changing temperatures. Even with quick changing pH values such as titrations, the iodine/iodide reference system is beneficial.

Chapter 3: pH glass electrode types

Problem

There are many different pH glass electrodes on the market. Each pH glass electrode has particular qualities so they should be chosen carefully to suit the measurement application.

Question

What different kinds of pH glass electrodes are available? What are the main characteristics of these electrodes and which membrane glass is recommended for which measurement application?

Answer

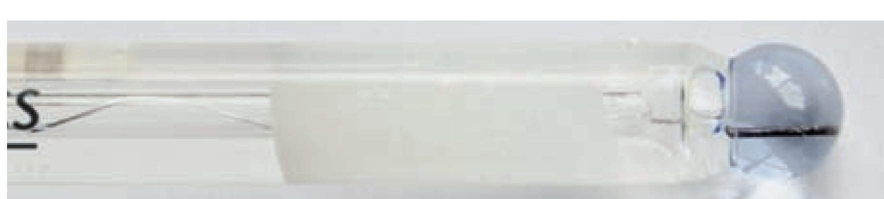
Over time the glass membrane of a pH glass electrode changes due to the process of taking pH measurements. Because of exposure to water, alkali ions dissolve from the glass surface and oxide groups of the silicate become OH groups which causes a source layer. This source layer appears to hydrogen ions as an ion exchanger. Using a special pH glass electrode membrane there is a reproducible balance between the sample solution and glass surface, which is only dependent on the hydrogen ion concentration in the solution and the source layer 4.

Because pH glass electrodes have numerous different capabilities many different kinds of membrane glasses are needed to make accurate and reliable pH measurements for all applications. SI Analytics offers five different types: L-, H-, S-, A- and N-glass. The main characteristics of these pH glasses are:

- L: Wide application range, very low impedance resulting in accurate and rapid response times over a large temperature range 3
- H: Optimized for higher temperatures up to 275 °F (135 °C) and extreme pH-values, high accuracy in stronger alkaline range (Na^+)
- S: Tolerates sudden temperature changes, provides constant measurement values with fast response time in hot alkali solutions
- A: Fast response time in drinking water, surface water, sewage, and general applications
- N: At normal temperatures usable for the full pH-range and almost all kinds of samples.

The following examples illustrate the use of different pH glass electrodes: With a strong alkaline media the so called "alkaline measuring error" appears. This error is triggered by the confusion of sodium with hydrogen ions (cross sensitivity) and causes a measurement inaccuracy beginning at a pH value of 12 in presence of sodium ions. Under extreme conditions this inaccuracy could mean a

3 *Blue pH glass bulp of a pH electrode*



Chapter 4:
pH calibration and pH solutions

difference up to 1 pH unit. In those cases the H type glass electrode should be used.

Applications with hot alkaline treatments or sterilization by superheated steam impose great demands on the consistency of the membrane glass. Under these conditions a pH glass electrode usually ages faster and corrodes. In this case the right choice would be a S type pH glass electrode.

In common applications or drinking water measurements the challenge is the variety of applications and the low conductivity of the pH glass electrodes. This could lead to slow response times and unstable or unreliable data. For these demands the A type glass has been developed. It features rapid response times and extended use.

Conclusion

The characteristics of the membrane glass determine the quallity of the characteristics of the pH glass electrodes. Only the right choice of pH glass electrode will provide you with the highest accuracy and reliability.

Problem

To calibrate pH measuring systems you must use a solution with a known pH value, also known as pH reference or buffer pH solution. The accuracy of your subsequent pH measurements is dependent on how accurately the pH measuring system is calibrated, so particular attention must be paid to this step. Because there are a great number of different buffer pH solutions available many people are uncertain about how many and what pH calibration solutions should be used.

Question

What is a buffer pH solution and how many pH calibration points are reasonable?

Answer

A buffer pH solution is composed of either a weak acid and the conjugated base or a weak base and the conjugated acid. The main characteristic of a buffer pH calibration solution is that the pH value of the solution will not alter when a small amount of acid or a base is added. Dependant to the used components and their concentration the pH value of the buffer solution can be set over nearly the complete pH range, e.g. with HCl and sodium citrate (pH 1–5), citric acid and sodium citrate (2.5–5.6), acetic acid and sodium acetate (3.7–5.6), Na_2HPO_4 and NaH_2PO_4 (6–9) or borax sodium hydroxide (9.2–11). The pH value of the calibration solution does not only alter with its composition but with temperature changes. An exact specification of reference pH calibration solutions is given by the DIN 19266. The thermal characteristics of these buffer pH calibration solutions have been determined by metrological institutes [5] (see Table 2).

Table 2: Temperature behavior of reference pH buffer

Temp. in °C	pH		
10	3,997	6,923	9,332
20	4,001	6,881	9,225
25	4,005	6,865	9,180
40	4,027	6,838	9,068
50	4,050	6,833	9,011

In contrast to reference pH calibration solutions the composition of technical buffer pH solutions is not regulated. So it is important to note that the temperature reaction of those pH calibration solutions can be manufacturer-specific, even if the same nominal pH value is specified at 25 °C. In particular at a calibration temperature other than 25 °C considerable errors can occur with the pH measurement results. In addition to different kinds of buffer pH solutions the calibration procedure plays a major role in determining the accuracy of the pH measurement. The following pH calibration procedures are described in detail in DIN 19288.

- One-point-calibration: A one-point-calibration is accomplished using one reference pH calibration solution. Here only the zero point of the pH electrode is verified and it is assumed that its slope is close to theoretical Nernst slope. This method of pH electrode calibration is the fastest. It is recommended to use this calibration method for comparative only and not for absolute measurements.

- Two-point-calibration: This method is accomplished using two reference pH calibration solutions, with a minimum pH difference of two units. Here the maximum measurable pH value and zero point of the pH electrode are determined by a linear slope cutting through the measuring points (in the application of the measured mV against the nominal pH value of the buffer solution).

Chapter 5:
Accuracy of the pH measurement

- Multipoint-calibration: A multipoint calibration is accomplished with three or more reference pH calibration solutions. The difference between pH solutions should be greater than 0.5 pH units. The pH electrode calibration curve is determined by either linear regression through all measuring points or built from segments between neighbored buffers in which the zero point and slope can be calculated. To evaluate the certainty of the calibration procedure the stability index (R2) could be consulted. It shows whether the theory correlates with the results and should have a value around 1. Often alkaline buffer solutions are used to accomplish a multipoint calibration. These should be checked for freshness and percentage error effect has to be estimated.

Generally a two-point-calibration with DIN buffer pH calibration solutions 4.01 and 6.87 is sufficient, because they are very stable. Furthermore pH electrodes offer due to their high linearity a sufficient measuring security beyond the pH values of the used buffers. Even for additional coverage the two-point-calibration can be checked through an additional measuring of a buffer solution within the range of the estimated pH value.

Conclusion

The higher the required accuracy of the pH measurement, the higher the need for DIN-19266 buffer pH calibration solutions, which provide an accuracy of under 0.01 pH. Multipoint-calibrations should increase the accuracy and for most pH measurement applications a two-point-calibration will be satisfactory.

Problem

The question of the accuracy of pH measurement is not easy to answer because there are many factors that are often not or not precisely known to even the experts. However, one thing is certain: The pH value shown on the pH meter says nothing about its accuracy. The number of decimals is always deceptive in showing an excessively high accuracy.

Question

What are the key factors and how can the accuracy be determined?

Answer

In metrology, the uncertainty is likely selected as a standard for the measurement accuracy. The lower the uncertainty, the higher the measurement accuracy. This uncertainty is a part of every measured value. It is composed of the uncertainties of the individual contributions to the measured value. This difficult subject for the pH measurement is presented easily understandable for the user in standardDIN 19268 [6]. The important temperature effect is disregarded in the standard for the sake of simplicity, and adhering to the temperature constant is assumed. The following, however, must still be included:

- pH of the buffer solutions with uncertainty,
- Uncertainty of the measured values in buffer solutions and
- Uncertainty of the measured value in the sample solution.

In order to ensure a high measurement accuracy for the calibration, buffer solutions according to DIN 19266 are recommended, in which various manufacturers already specified the measurement uncertainty.

Now the question arises as to the uncertainty of the measurement values in these buffer solutions during calibration or adjusting. A dissolution of ± 1 digit is assumed for the pH meter. This corresponds to 0.2 mV or 2 mV (depending on the dissolution of the pH meter and its digital display). Then the question of the uncertainty of the pH measuring chain voltage remains. Assuming that the pH glass electrode operates linearly up to pH < 12 prior to insertion of the "alkaline error", the reference electrode with the junction and the interference potential, the liquid junction potential (LJPs) remain as a critical point. The LJPs in buffer solutions according to DIN 19266 in reference/bridge electrolyte amount to about –2.5 mV at 3–4 mol/L KCl. If the measurement solution has approximately the same composition (if a buffer solution would be the sample), the LJP would also be

Table 3: Examples for measurement inaccuracies

Calculation in accordance with DIN 19268		Expanded inaccuracy ± U (k = 2)		
Measured value	value	Case 1	Case 2	Case 3
Puffer1	4.008	0.01	0.02	0.02
Puffer2	6.865	0.01	0.02	0.02
Measurement voltage 1 [mV]	174.6	0.2	0.2	2
Measurement voltage 2 [mV]	6.6	0.2	0.2	2
Measurement voltage x [mV]	-1.4	0.2	0.4	3
Measurement voltage x [pH]	7.001	0.023	0.045	0.131

in the same order of magnitude. If the composition of the sample solution is not the same, but similar, 0.2 mV is (arbitrarily) added to the uncertainty of the measured values during calibration. If the type and concentration of salts, acids or lyes in the solution significantly varies, the LJPs increase and can only be calculated or estimated according to elaborate equations (e.g. Henderson). The calculation of measurement uncertainties according to DIN 19268 are shown in Table 3 for three different cases. Now the user must decide which case is appropriate for his measurement.

Conclusion

At higher demands to the accuracy of the pH measurement for estimation of the overall measurement uncertainty, the knowledge of type and dimension of the measurement uncertainties in detail are required. This estimation can be eased by DIN 19268. The optimal choice of pH electrode and buffer solution helps reducing the uncertainty.

Chapter 6: Temperature effect – uncertainty in the pH measurement

Problem

Varying temperatures affect the measurement of the pH value. These must therefore be included in the uncertainty of the measurement.

Question

What effect does the temperature have in the pH measurement? What are isotherms? How does the temperature compensation work? How does the pH value of buffer solution and the sample change with the temperature?

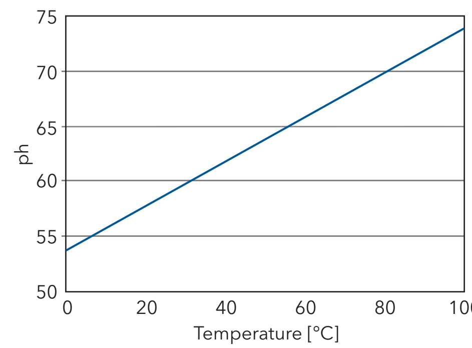
Answer

The voltage of the pH combination electrode changes with the temperature. This behavior can be described by the Nernst equation:
$U = U_{0+}(R \times T / n \times F) \times \ln a_{H^+}$ with

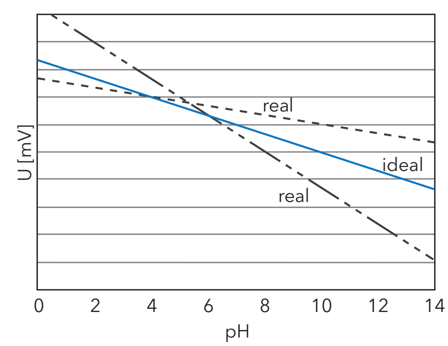
- a_{H^+}: Activity of the hydrogen ion
- U_0: Standard potential
- R: Gas constant 8.3144 J/K*mol
- T: Temperature
- F: Faraday constant 9,6485*10^4 C/mol
- n: Number of electrons transferred

The Nernst factor (R*T/n*F) indicates the theoretical slope of the electrode. This factor is temperature dependent, it varies between 54.20 mV/pH at 0 °C and 74.04 mV/pH at 100 °C.

In real electrodes, the slope never exactly corresponds to the Nernst factor. In addition, the zero point of the measurement chain, especially in heavily aged electrodes, is temperature dependent. When recording the voltage of a real electrode at two different temperatures at different pH values, a characteristic curve is obtained for each temperature. These characteristics, called isotherms, intersect in the isothermal intersection. This intersection can vary markedly from the zero point of the ideal characteristic 5. When conducting measurements at many variable temperatures, you can even receive a field of isotherm intersections 2.



4 *Temperature dependency of the Nernst factor* 3



5 *Characteristics of a real and an ideal electrode*

The temperature compensation of pH meters only takes into account the change of the theoretical slope in temperature changes. When calibrating the metering device at a certain temperature and measures at another temperature as the calibration temperature, the temperature compensation adjusts the slope according to the theoretical change of the Nernst factor. Non-ideal behavior of the slope and the zero point is not recorded here. This plays a minor role for less critical applications. However, in measurements with far deviating temperatures that required maximum accuracy, the measuring chain must be calibrated for each measuring temperature with buffers at the same temperature..

The temperature responses for buffer solutions were precisely studied by metrological institutes. DIN buffer solutions are precisely specified by DIN 19266. These buffers show a temperature behavior such as shown in Table 4 5.

Technical buffers display a different temperature behavior than DIN buffer solutions, and their compositions are not defined, i.e. each manufacturer can produce his own mixture. Incorrect measurements can result here due to the lack of knowledge of the temperature responses of the buffer solutions.

The specific temperature dependence of the hydrogen ion activity of the sample is almost never known and therefore can neither be compensated nor be converted to a reference temperetaure as at the conductivity measurement. Hence it is mandatory to note the temperature at which the pH value has been determined. A comparison of the pH values of the same sample at different temperatures is nearly impossible. This frequently results in great variations between operational pH measurements at elevated temperatures and the measurement of the sample in the laboratory at room temperature.

Conclusion

The electrode zero point and slope, in practice, can have deviations from the ideal behavior, which is described by the Nernst equation. The greater the difference in the temperature between the calibration and measurement, the greater the measurement deviations. Deviations from 0.05 to 0.25 pH are possible, depending on the difference between the calibration temperature and the measurement temperature 4 5.

The calibration and measurement should be performed at the same temperature for a possibly precise measurement. Based on the more precise specification, buffer solutions according to DIN 19266 should be applied for the calibration.

In order to evaluate the measurement results and for a complete documentation, the measurement temperature, the electrode used and the calibration conditions must always be specified with the result of the pH measurement. A conversion of the pH value of a sample from the measured temperature to another temperature is not possible.

Temperature in °C		pH	
10	3,997	6,923	9,332
20	4,001	6,881	9,225
25	4,005	6,865	9,180
40	4,027	6,838	9,068
50	4,050	6,833	9,011

Table 4 : Temperature behavior of various DIN 19266 buffer solutions

Chapter 7:

Acid and alkaline errors in the pH measurement

Problem

What effects can occur during measurements in solutions with extreme pH values?

Question

What are acid and alkali errors? Under what conditions do they occur? What impact do they have?

Answer

Even measuring chains, which respond ideally over a wide pH range, i.e. linear, can display deviations in the very acidic (< pH 2) or basic (> pH 12) range 6 2.

The effect of these deviations is that too high pH values are displayed in the acid medium and too low pH values in an alkaline medium. In the first case, the acid error is stated and in the second case, the alkali error.

The acid error is generally lower than the alkali error. One cause of the acid error is the incorporation of acid molecules in the gel layer or the change of water activity, resulting in reduction of the H^+ ion activity 2. It is only observed under very extreme conditions in practice. In addition, high concentrations of acids dehydrate the source layer by osmotic pressure and accumulate the hydroxyl groups. Both results in apparently higher pH values 7.

The alkali error is much more relevant to the reliability of the measurement. It occurs when the measuring solution contains alkali ions (e.g. lithium or sodium) and has a pH value of greater than 12. Under these conditions, there is an exchange of alkali ions in the gel layer of the membrane glass and in the measuring solution. This cross sensitivity is also known as sodium error, since a sodium hydrozide solution is frequently used for setting very high pH values 3. Figuratively speaking, the alkali metal ions are detected in addition to the H^+ ions, simulating a lower pH value. Depending on the type of pH membrane glass, the pH value of the measurement solution, the temperature and the alkali ion concentration, the alkali error can amount up to one pH unit.

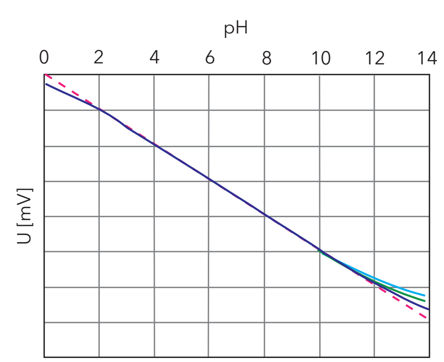
The alkaline error is slight in modern pH glasses. Results from the measurement of pH electrodes with various pH membrane glasses are compared in table 5. The measurements were each made in solutions of the same pH value (once with sodium ions and once without). The concentration of sodium ions equaled 1 mol/l. In order to obtain the maximum accuracy, a pH glass that possibly has a slight alkali error should be noted at this high pH value and high concentration of sodium ions.

	pH value without sodium ions	pH value with sodium ions	Alkali error
Electrode 1	13,72	13,15	0,57
Electrode 2	13,77	13,45	0,32
Electrode 3	13,98	13,63	0,35
Electrode 4	13,78	13,21	0,57
Electrode 5	13,80	13,25	0,55

Table 5 : Measurements with different membrane glasses in a solution with pH 14 without and with an addition of sodium ions (concentration 1mol/l).

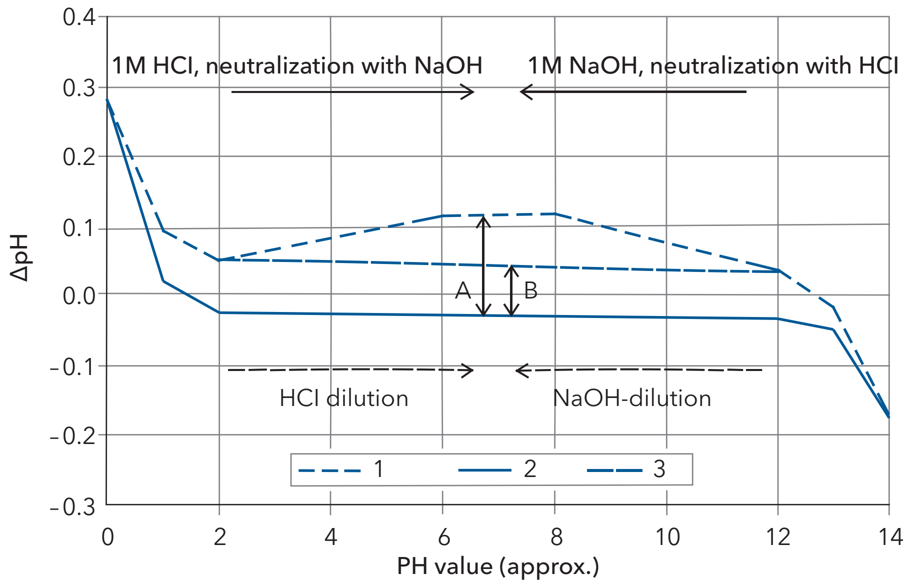
Conclusion

In order to achieve the highest possible accuracy of pH measurements, even under extreme conditions, the electrode should be selected to suit the application. At high alkali concentrations and high pH values, a pH electrode with a minimum of alkali errors should be selected.



6 Exemplary mV curve of various electrode for different pH values.

Chapter 8:
Diffusion potential as a error source



7 *Course of the measurement error of a pH electrode*

Problem

Diffusion potentials are often referred to as a disturbance variable in the pH measurement. However, their size and influence on the measurement accuracy are rarely known. Diffusion potentials were calculated for several examples and compared with practical measurements. In simple systems, the calculations were confirmed 8 9.

Question

How great can diffusion potentials be and how do they affect the accuracy?

Answer

The Henderson equation is usually applied for calculating the diffusion potentials. This requires that concentration, the mobility and the charge of all the ions involved in a sample are known. This means that if only one parameter is unknown, the calculation cannot be performed. In most solutions, however, even the composition is not precisely known. A number of assumptions must therefore be applied when calculating the diffusion potentials, which then results in a rough estimate of the expected measurement errors. Therefore, the following deliberations must be applied:

As a reference or bridge electrolyte, a three molar KCl solution is usually used. It should also be the basis for the calculation of the diffusion potentials according to Henderson.

The size of the diffusion potentials is essentially determined by the differences in the mobility of all the types of ions. Therefore, the contact with hydrochloric acid and caustic soda is therefore observed here regarded as an adverse event.

Since errors in the pH measurement must be considered here, the calculated diffusion voltages are converted into ΔpH at 25 °C and presented against the pH value of the solution 7.

The change of the pH values must again be achieved by a dilution (7 1) with water and once by neutralization (7 2). The figure shows the calculated variations in measurements ΔpH versus the pH value of the solutions for the mentioned cases. The following areas must be considered:

- Errors can greatly increase in extreme pH values.
- Extremely high values are measured in the acid range and extremely low values in the alkaline range.
- The error increases at great dilutions (purest water A). If the ion strength is higher, for example at a conductivity greater than 1 mS/cm, the measurement errors from diffusion potentials are lower (3,B).

Conclusion

In solutions with conductivities greater 1 mS/cm and in the range of $2 < pH < 12$, the effect of diffusion potentials on the uncertainty of the pH measurement is approximately $\Delta pH < 0.05$. In the estimation of the measurement uncertainty, however, any additional sources of errors must be taken into account.

Chapter 9:
Selection of the pH electrode

Problem

It is crucial for the measurement reliability and the service life of a pH electrode to find the most suitable design for the application.

Question

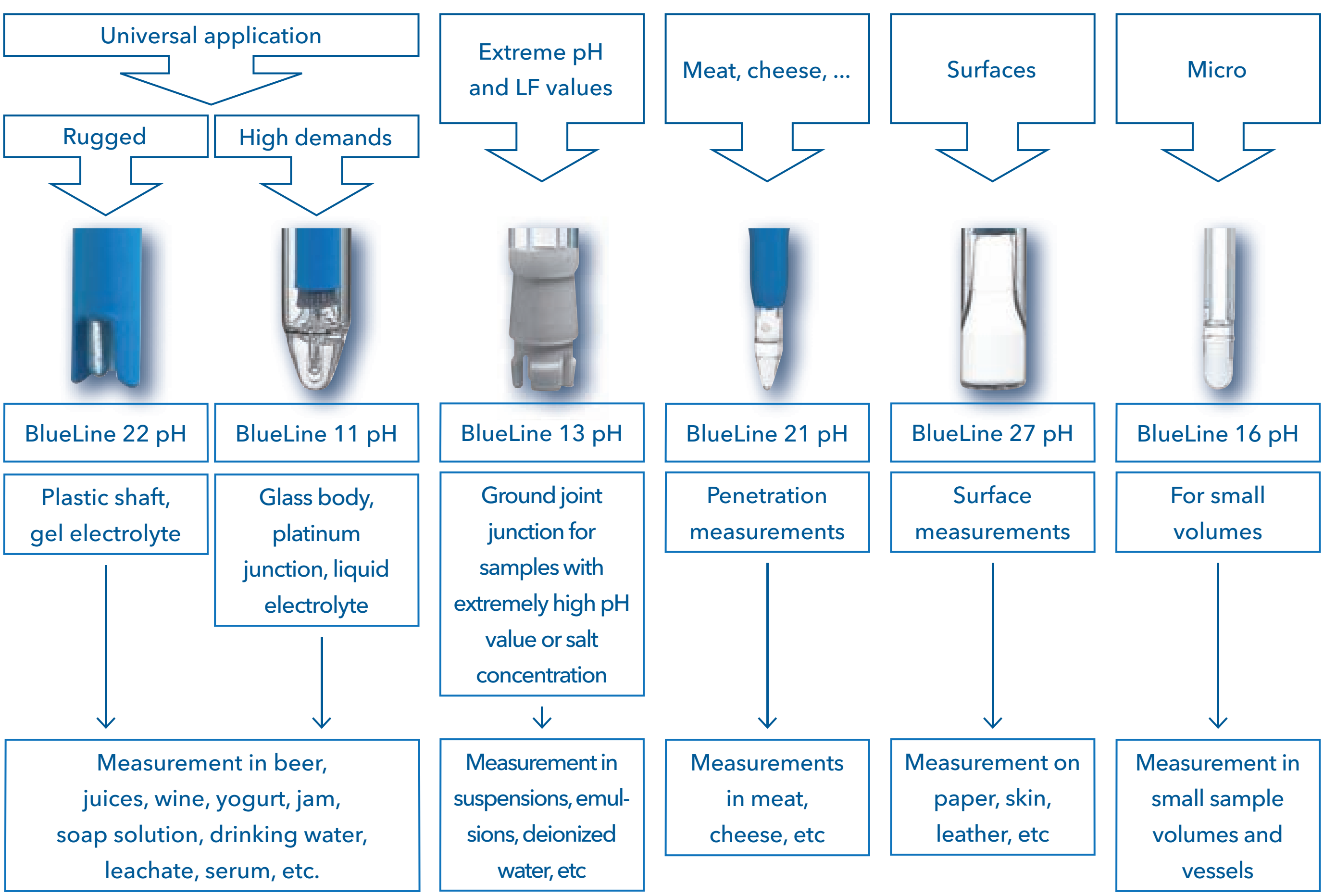
It is crucial for the measurement reliability and the service life of a pH electrode to find the most suitable design for the application.

Answer

As varied as the applications in which the pH value is measured, is the number of electrode types. These differ from one another in style and shape of the membrane glass, the reference system, the material and the length of the shaft up to the connection to the measuring device 8. In order to find a suitable electrode, it is easiest, to go through the following two checklists for the type of sample, and the design requirements of the electrode:

First, the user should deal with the type of sample and measurement conditions. The answer to the following questions helps here:

- At what temperature is measurement and calibration conducted? What is their pH application range? This information is important in the selection of the electrolytes (e.g., liquid or gel) and of the reference system and the membrane glass type.
- What conductivity of the sample solution is present? How high is the water content? Are solids or still undiluted components in the measuring solution? For samples with a low conductivity or a proportion of solids, for example, an electrode with liquid electrolyte and platinum or ground junctions provide for a stable electrolyte discharge and thus for accurate measurements.



8 Choice of different electrode types and their applications

- What is the consistency of the measurement solution? It makes a difference, for example, whether a puncture measurement or a measurement is performed in the solution.
- Are sulfide, bromide, iodide or other unwanted electrode poisons present within the solution? The reactions in the electrode can be avoided by the selection of the reference system and the junction.
- Is the measurement performed in aggressive compounds (such as HF or hot sodium hydroxide solution)? This information helps in the selection of the shaft material and the membrane glass.

Once these issues have been resolved, the design requirements for the electrode must be determined:

- Which installation length and diameter is required? This information is required when e.g. measuring in special vessels.
- What accuracy of the electrode is necessary, which strength is required? This information is important to decide whether a gel electrode with a plastic shaft or a liquid electrolyte electrode with a glass body is used.
- Will a temperature sensor be integrated in the electrode or not? What connections does the measuring device have for the electrode? This is important, in order to provide the appropriate connection of the electrode to the measuring device.
- Is the application area of the pH measurement in the laboratory or process? When the electrode is used in the process, it is important to clarify what pressure is applied in the measurement and how the electrode is installed. When used in the process, the electrodes have a special built-in Pg13.5 thread to be permanently installed at the measuring station via a holder. If liquid electrolyte electrodes are used under such conditions, a pressurization of the electrolyte storage must also be provided.

Conclusion

When selecting the electrode, it is important to coordinate it to the respective application. The user can only then assume an optimal service life and accuracy of the measurement.

Chapter 10: Care of the pH electrode

Problem

How do pH electrodes have to be maintained/cared for and stored?

Question

What influence does the maintenance and care have on the service life of the electrode and the accuracy of the measurement? How should the electrode be stored? What cleaning methods are there?

Answer

Careful handling and storage of the electrodes are elementary for reliable results. Furthermore, the durability is thereby increased. The following tips show an overview 10 2 3:

- Storage:
  An electrode should never be stored dry, but always in watering solution. The watering cap should be filled with the following solutions depending on the type of electrode:

• Single-rod measuring cells and reference electrodes: In case of liquid electrolyte electrodes, the electrolyte solution in the reference electrode should also be used for watering. 3 mol/l KCl solution must be used in gel electrodes.

• Glass electrodes: In case of pure measurement electrodes, the watering cap can be filled with deionized water. For single-rod measuring cells and reference electrodes, this results in a reduction of the service life.

If the electrode has been stored incorrectly dry, it must be watered for at least 24 h in the above solutions before its first use. The functionality must be tested by calibrating prior to the measurement.

Cleaning:
Dirt deposits of any kind on the membrane surface or the junction may result in the reduction of the service life of the electrode and inaccurate measurements. The electrode should preferably be chemically and not mechanically cleaned. In the event of dirt deposits outside the electrode and the junction, the following cleaning processes can be performed:

• Inorganic adhesions: Put the electrode for a couple of minutes into 0.1 mol/l HCl or 0.1 mol/l NaOH. If the buildup is not resolved, the solution should be a cautiously heated up to 50 °C before the acid or alkali concentration are increased.

• Organic adhesions: Rinse the electrode with organic solvents. The membrane can be carefully and briefly wiped with a damp, lint-free, soft cloth . The resistance of the plastic shaft of the electrode to organic solvents should be noted in this treatment.

• Proteins: Placing the electrode in a pepsin/HCl solution for at least 1 h.

• Sulfides on the ceramic junction: Store the electrode in a thiourea/HCl solution (7.5 % in 0.1 mol/l HCl) until the discoloration on the junction has disappeared. After cleaning, the electrode is rinsed with deionized water and placed in the electrolyte solution for at least 1 h. In addition, the electrode must be recalibrated prior to the next measurement.

Cleaning of the reference electrode with liquid electrolyte:

• In case of dirt/particles in the reference electrode: remove the old and refill with new electrolyte. If necessary, repeat until the dirt is removed. Some heated electrolyte (about 45 °C) can also be used. An internal chemical cleaning is not advised, since the reference system can be irreversibly damaged.

• KCl crystals in the interior: The crystals can be dissolved when heating the electrode in a water bath at 45 °C. Then the electrolyte must be completely replaced.

General treatment recommendations:

• After the measurement, the electrode must be rinsed immediately with deionized/distilled water and stored in the recommended manner.

• The electrode is regularly inspected for dirt deposits on the membrane surface, the junction and the interior.

• Measurements in aggressive and/or hot media result in a reduction of the service life.

• When using electrodes with liquid electrolyte, the filling opening must be opened during the measurement/calibration, in order to prevent a back diffusion of the sample by the electrolyte flow. The refilling opening must be closed when storing and between the measurements.

• The use of deionized water as a storage solution for any electrode reduces their service life.

• Never store the electrode dry, use it as an agitator or clean it mechanically.

Conclusion

The general treatment recommendations contribute greatly to the service life extension of the electrode and thus to the accuracy of the measurement.

Chapter 11
Qualifications of the pH measurement

Problem

pH measurements are operated in GMP/GLP-related companies for quality control of both raw materials and finished products. The measured pH values therefore are highly relevant in determining whether the sample meets the requirements or not. Accordingly, measures must be taken to ensure the accuracy of the measurement.

Question

What measures are available to ensure the pH measurement, and how are they performed?

Answer

The qualification process consists of up to four consecutive test stages [9]. They include the following steps that must be documented accordingly:

- DQ (Design Qualification): The user formulates the requirements for the components and operating conditions in the DQ prior to purchasing. Described are the purpose of use, environmental conditions, technical data, a description of the samples, as well as general and special requirements based on the application [11]. The DQ is therefore the documented evidence that the instrument is designed and manufactured in accordance with the requirements and the user receives exactly what he needs.
- IQ (Installation Qualification): The IQ is conducted at the site of the installation. The completeness of the system and the environmental and application conditions are examined after delivery. The IQ provides evidence that the delivered instrument meets the specifications of the order (DQ), is properly set up at the intended work area and is properly installed for the environmental conditions there. A first test can already be included in the IQ. After this training, the system is ready for use.
- OQ (Operational Qualification): The OQ is used to check whether the installed system complies with the general conditions of the technical and functional specifications. The test includes a test of the device at the point of use. A comparison with the technical data of the components or a test with a standard can be performed, which can be attributed to a national standard. For a pH measuring system, this means the determination of the pH value of DIN buffer solutions after the calibration of the device.
- PQ (Performance Qualification): The PQ is used to demonstrate that the measurement system consistently provides a performance according to specifications under real operating conditions. During the IQ and OQ, which must be carried out once, which the suppliers often offer in the form of prefabricated documents up to the implementation of the qualifications, the PQ is usually performed by the user on a regular basis. The testing interval is determined according to the application of the measurement system [12].

Conclusion

The individual tests of the pH meter and electrode yield only a statement about the current functioning of the electrode and the pH meter as individual components, but no statement about the continuous validity of pH measurements of the entire system. The qualification beginning from the design qualification prior to the purchase, over the one-time installation (IQ) and Operational Qualification (OQ) at the corresponding work station up to the routine performance qualification (PQ) together provide verification that the complete measuring system (consisting of pH meter, pH electrode, buffer solutions) yield a consistent performance according to specifications under the specific conditions.

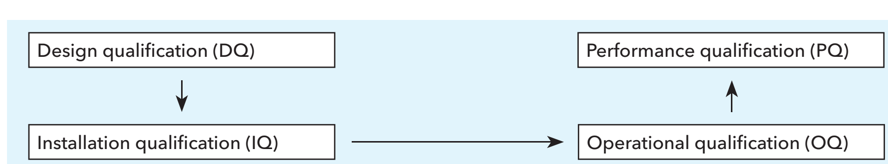


Fig. 9

Chapter 12:
pH measurement in organic media

Problem

The requirements for the feasibility and accuracy of pH measurements and titrations in nonaqueous media for process and quality control increase steadily in the pharmaceutical industry.

It is therefore important to examine to what extent one can speak at all of a classic pH-measurement in such analyses and how the electrodes respond in such a medium.

Question

Under what conditions are pH measurements and titrations possible in non-aqueous media?

Answer

The pH value in accordance with DIN 19260 [13] is only defined in aqueous media. However, analog to the dissociation of the water:

$$2H_20 \leftrightarrow H_3O^+ + OH^-$$

similar observations for aqueous solvents can be employed and the following equation can be employed:

$$2HLy \leftrightarrow H_2Ly^+ + Ly^-$$

H_2Ly^+ is the protonated solvent molecule and is called Lyonium ion. Ly^- is the deprotonated solvent molecule and is called Lyat ion. Aprotic solvents such as DMSO or benzene do not dissociate from the equation. Only water-like solvents with a dissociation such as Ethanol allow the introduction of a pH scale. This results from the pKLy value of the solvent. Thus, the scale for water contains 14 units, 16.7 for methanol and 19.1 for ethanol.

With the creation of individual, that is solvent-dependent, pH scales, however, only the first step is accomplished. It requires then also individual reference buffer solutions to calibrate the electrode under these conditions. If the pH electrode is calibrated with aqueous buffer solutions and a pH measurement is then performed in an aqueous medium, this corresponds to the proverbial comparison of apples and oranges. The absence of reference buffer solutions based on the particular solvent may therefore not be followed with a conversion of the actual measured value mV, as delivered by pH-electrodes, into a pH-value.

In contrast to the pH measurement, the absolute pH value is not the relevant value for titrations, but the change of pH value. The consumption of titrant up to this pH jump is applied for the content calculation. Under such conditions, the conversion of the original mV measured value of the electrode into a pH-value is possible, but this conversion value is just as little reliable as an absolute measurement value.

In addition to the lack of individual reference buffer solutions and the associated lack of knowledge of the hydrogen ion activity in non-aqueous solvents, the challenge for the pH measurement in such samples, among others, is subject to the following two phenomena:

- The increased phase boundary voltage on the junction upon contact of the non-aqueous solvent with the reference electrolyte of the electrode complicates the pH measurement [14].

- The low conductivities of these solvents also result in problems. The effect of low conductivity is shown in very fluctuating measured values even at pH measurements in distilled water. Organic solvents even increase that effect.

The electrodes or their membrane should be conditioned or formed to the proper solvent even for recording the mV value. With immersing the electrode into the solvent the resistance of the glass membrane is reduced and a faster response time of the electrode is guaranteed [3].

Conclusion

No measurements to determine the absolute pH value in non-aqueous solvents (i.e., having a water content of less than 30 %) may be carried out, but only direct mV measurements.

With an increased setting period in these media, a pretreatment or formation of the electrode may also be anticipated [15].

References

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Index
Electrodes

ProcessLine Process electrodes for measuring pH, temperature and redox potential

One for all applications – for highest demands

ProcessLine electrodes are low maintenance sensors for heavy duty process applications, as they are especially present in the chemical industry.

They are ideally suitable for measuring media with extreme ionic strength – whether boiler feed water or brine – also in strongly oxidizing acid and alkali containing media.

The ProcessLine electrodes' special design with regard to accuracy, stability, rapidness and durability is very close to the one of liquid electrolyte electrodes, although the ProcessLine does not require refilling the electrolytes and its complex pressure sequence regulation. Therefore the ProcessLine electrodes require only low-maintenance, including calibration and adjusting efforts, hence offering a high potential for cost savings.

Duralid solid electrolyte with high content of KCl and special formulation

The solid reference electrolyte Duralid does not require a special junction – the reference system holds a direct contact to the measuring media via the two open connections. This minimizes the risk of contamination/blockage of the junction – the main source for measuring failures and even outfall – and guarantees long durability and high accuracy.

The long lifetime and small liqiuid junction potential resulting in high accuracy measurements of the ProcessLine elctrodes is based on the special formula and fabrication of the Duralid electrolyte:

- High content of the conductivity salt potassium chloride in polymer and therefore high electrolyte output into the measuring media, reduces the interferences of the measurement through diffusion potentials between the junction of reference electrode and measuring media.
- The special distribution of the potassium chloride in the Duralid polymer counteracts positively against a reduced durability of the reference system, by releasing a high quantity of electrolyte.

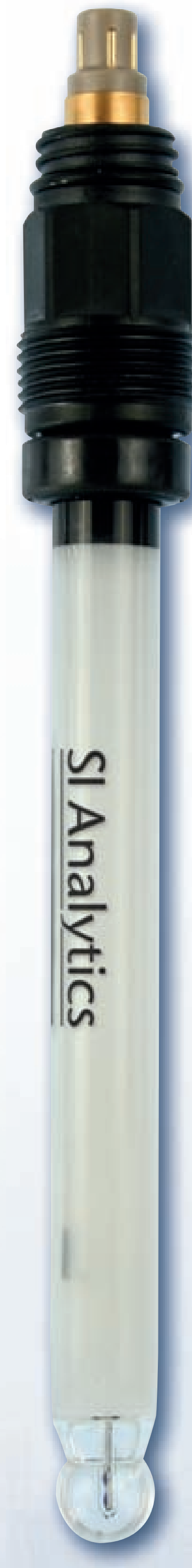
This special attribute given by the Duralid, does not only improve the durability and the response characteristic, it also enables stable measuring values – even under most difficult conditions such as changing flow rate/rotational frequency of stirrer or with measurements in organic solvents.

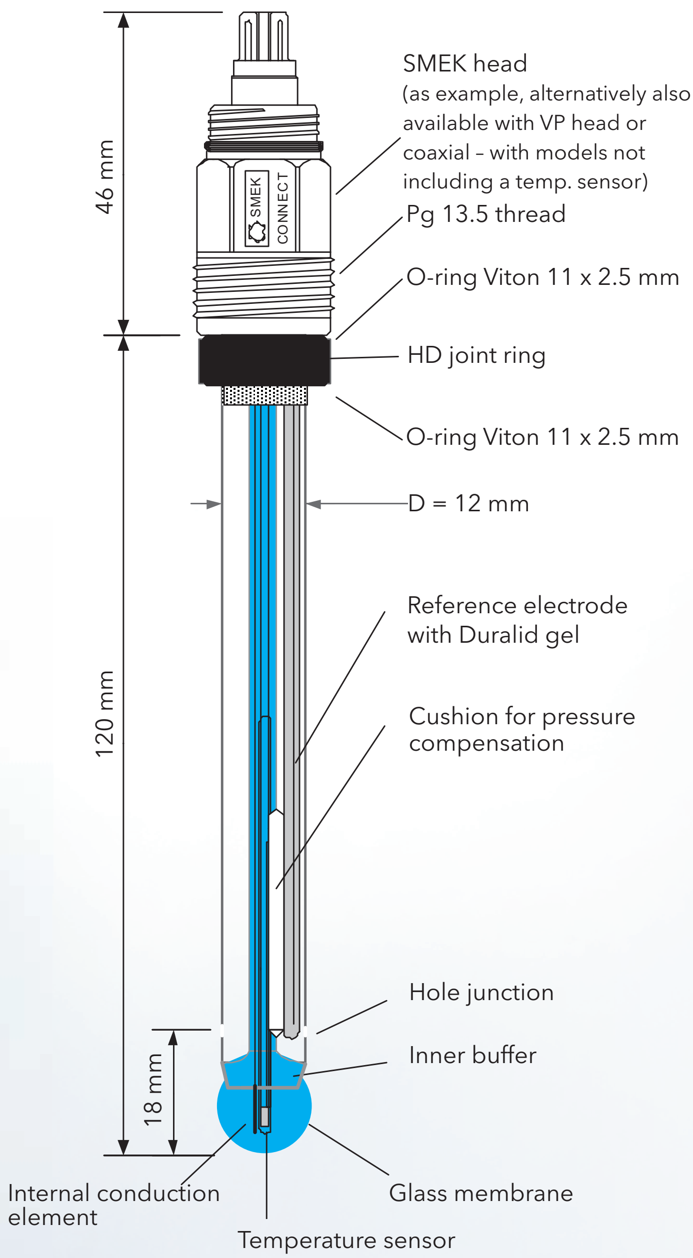
Cushion for pressure compensation in the reference electrode

Pressure and temperature fluctuations can easily be managed by the ProcessLine electrodes due to the integrated pressure compensation cushion inside the reference electrode.

Reliable H membrane glass

Besides the reference electrode, also the measuring electrode is of great importance regarding rapidness and accuracy of the measurement. The glass electrode of the ProcessLine series features a H membrane glass, a very high-quality and approved special glass. It excels by its high-temperature application range and very low alkaline errors. The special ball shape enables an optimal membrane resistance of 300 MΩ and ensures an easy cleaning.





- **Low maintenance**, i. e. no refilling of electrolyte or installation of complicated pressure sequence regulations.
- **Hole junctions**, therefore no contamination or blockage of the reference electrode.
- **Duralid electrolyte with high proportion of KCl and special consistency**
  Long durability as well as fast and stable measuring values. Furthermore, no substances of animal origin.
- **Buffer in the reference electrode** for compensation of pressure and temperature fluctuation.
- **Approved H membrane glass** with very low alkaline error and optimized ball shape.
- **Wide application range for media** with extreme ionic strength, strong oxidation character, high alkaline or acid components and also organic solvents.
- **Certificate for temperature and pressure resistance** of 12 bar at 0 to 130 °C.
- **Shaft length** from 120, 225, 325, 360 and 425 mm suitable for all assembling conditions.
- **Versions with Pt 100 and Pt 1000 temperature sensor** with SMEK- and also VP plug head for high flexibility.

Advantages ProcessLine

Process Electrodes

The ProcessLine electrodes take up a small part of our extensive process electrode program:
Further information is available in our specialized catalog “Process Electrodes” displayed and downloadable on our website; it can also be delivered personally on request.