

**PFAUDLER**

Glass-Lined Technology

# Liquid Analysis

Glass-Lined  
Instrumentation for  
Highest Standards



**GMM**  
**Pfaudler**

# PFAUDLER

— Glass-Lined Technology

For over 130 years, Pfaudler is the leader in developing new technologies to meet the highly specific chemical processing needs of its clients. One reason why our glass-lined equipment is trusted by over 90% of the world's top chemical companies is the sheer reliability of our reaction technologies and comprehensiveness of our glass-lined accessories. These technologies are critical to the safe containment of corrosive contents, maintaining the vessel pressure and ensuring the final batch quality.

In short, our glass-lined technologies are absolutely integral to an effective process.

## PRODUCTS & EQUIPMENT

### Glass Lined Reactors

### Glass Lined Mixing Systems

### Baffling Technologies

### Storage Tanks & Receivers

### Glass Lined Columns

### Accessories

### Glass Lined Instrumentation

### Glass Lined Heat & Mass Transfer



50/5/50t





# Technology and Benefits

## Advantages of the glass-lined measurement technology

### Technology

Glass lining is a unique composite material that optimally combines the advantages of steel and glass. As a result, it not only offers outstanding protection against many aggressive media, but it is also abrasion-, pressure- and temperature-resistant.

**This makes glass lining the perfect material for protecting measurement technology in demanding applications.**

But glass lining can do even more. Specially developed formulations react to H<sup>+</sup> ions in liquid media, which makes them suitable for **pH measurement**.

Embedding sensors in the glass lining not only delivers **redox potential** and **conductivity measurements** but also ultra-fast reacting **temperature measurements** and **corrosion monitoring**.

### Benefits

#### Highly resistant glass layer

- Resistant to aggressive acids, organic solvents and proteins
- Resistant to Cleaning In Place (CIP) and Sterilisation In Place (SIP) processes
- Resistant to abrasion
- Resistant to high temperatures
- Resistant to thermal shocks
- No catalytic or biological effects

#### Self-cleaning

- Prevents deposit formation with adequate flow velocity
- Suitable for adhesive products

#### Durable

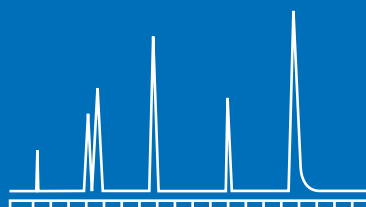
- Service life limited only by glass corrosion or abrasion

#### Robust steel body

- Withstands turbulences, shear forces and high process pressures
- Allows continuous inline monitoring
- No need for bypass lines, pumps, shutoff devices or retractable holders

#### Low maintenance

- No change in the pH characteristic curve over the entire service life
- Lower costs for recalibrations and cleaning processes
- Positive pressure effectively prevents diaphragm and electrolyte section contamination
- Maintenance intervals of up to one year
- Can be stored dry



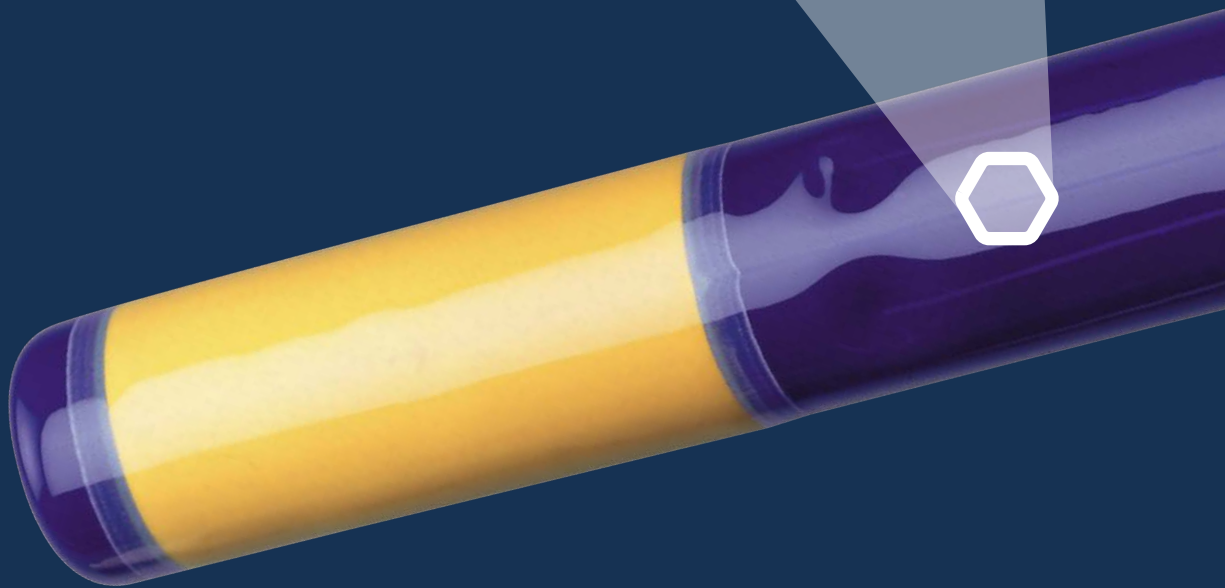
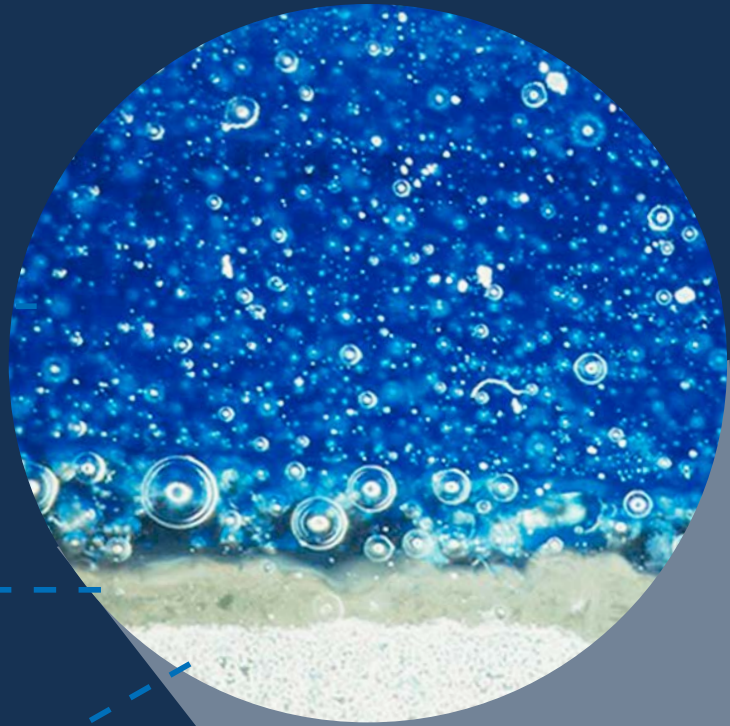
ANALYTICAL  
**DATA**

ION SENSITIVE  
**pH Value 2.0**

**TOP LAYER**

**GROUND  
LAYER**

**STEEL**



# Glass-lined pH Probes

## Long-lasting and low-maintenance

The pH value is one of the most important and commonly measured values in many fields of process engineering. The stability of the entire production process can be increased by regulating the pH value in a targeted way. Thanks to their maintenance-free operation and long service lives, robust glass lined pH probes are a cost-effective option for constant use.

### Steel probe body

The glass lined pH probe comprises a steel probe body with a highly-resistant, anti-adhesive technical glass lining to protect the surface in contact with the product. This makes the probe resistant to mechanical strain by flows, pressure, abrasion and vibrations.

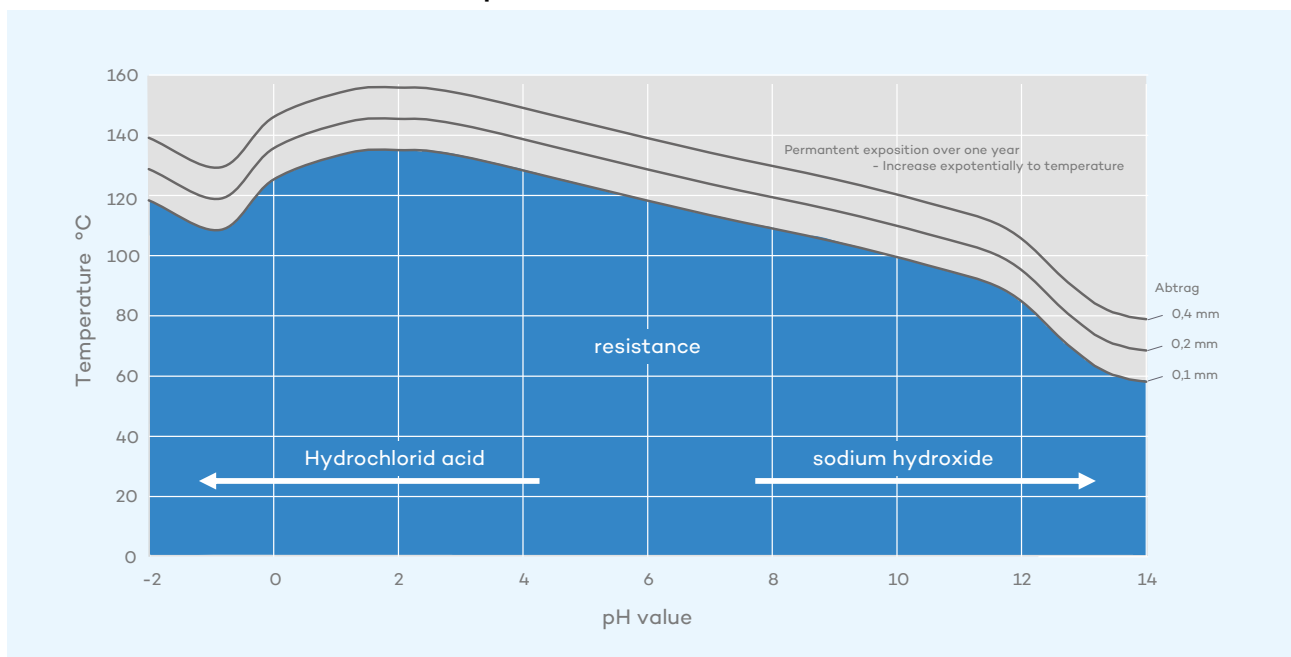
Probes can therefore be installed in piping and vessels where they are directly exposed to the flow, enabling direct continuous online measurement in the main product stream. Moreover, the smooth surface the glass lining gives the probe protects it against corrosion and product build-up. Combined with a pressurised electrolyte system, these properties allow the probe to be installed in any position and direction, so the pH sensor can be installed directly at the point of use.

### No aging

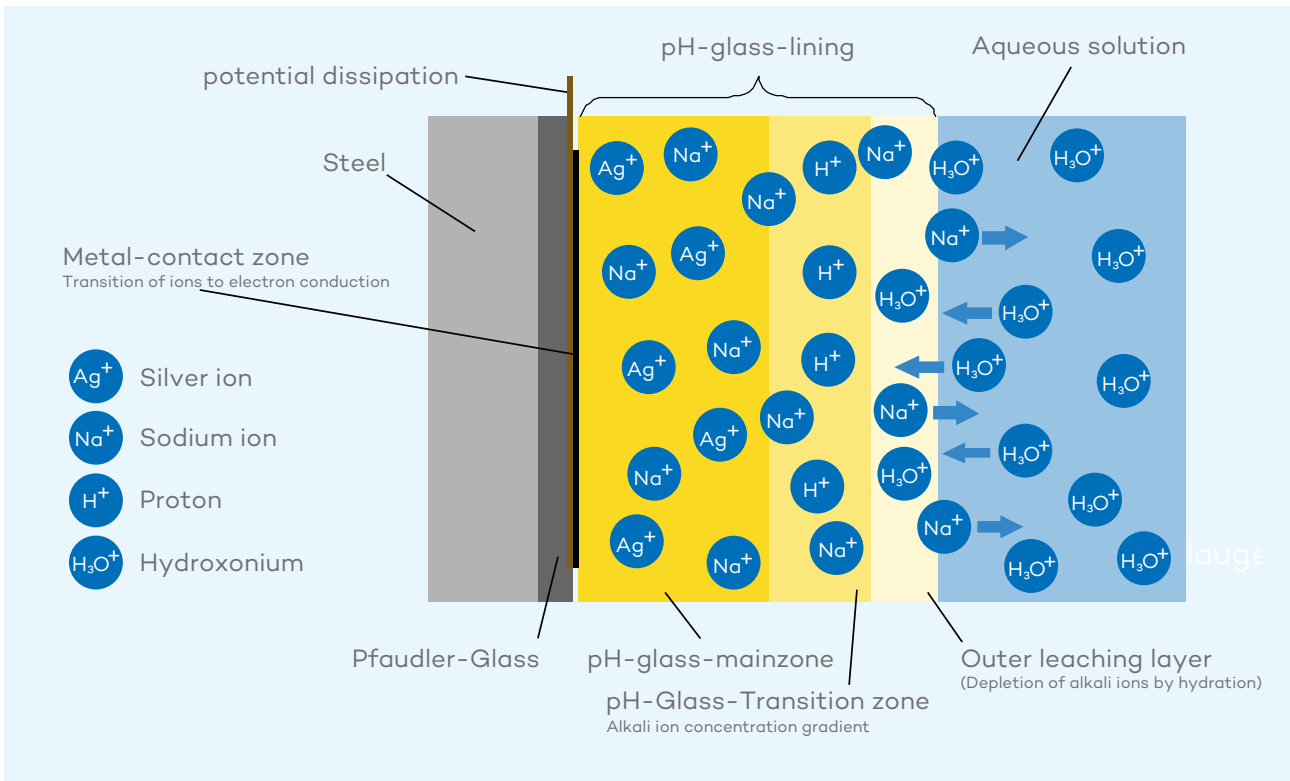
Unlike in glass electrodes, there is no internal buffer (discharge electrode). In contrast to conventional glass electrodes, the ion-sensitive glass area is only in contact with the process medium on one side. This prevents ageing and drift of the pH sensor. The operating life of a Pfaudler pH probe is depending of chemical corrosion and abrasion (diagram corrosion resistance).



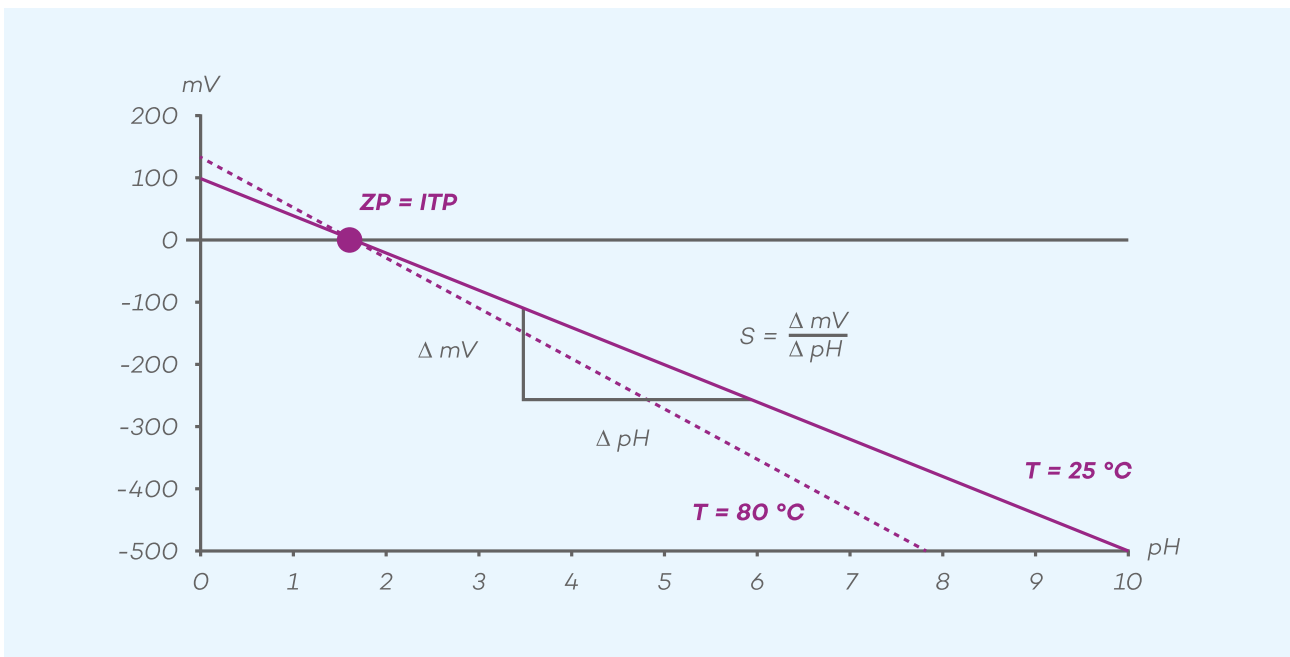
## Corrosion resistance of the Pfaudler pH-Glass



### Structure of pH-Glass-lining



### Characteristic curve of pH measurement



# Glass-lined pH Probes

For highest heavy-duty process standards

## Absolute pH-measurement principal

pH determination is a potentiometric (electrochemical) analysis method. A typical measuring setup with **absolute pH probes** comprises two electrodes – a measuring electrode immersed in a process medium and a reference electrode immersed in an electrolyte liquid. The measuring electrode generates a potential that clearly identifies the chemical condition (hydrogen ion concentration) of the medium to be measured.

The reference electrode provides a constant known potential that is independent of the composition of the process medium. A transmitter connected to the pH measuring probe calculates the medium's pH value from the difference in potential between the two electrodes, depending on the measured temperature - **The pH value is now an absolute pH value.**

HEAVY  
DUTY

PH  
MEASUREMENT



ROD PH-PROBE  
TYPE 03 N



ROD PH-PROBE  
TYPE 03 K



RING PH-PROBE  
TYPE 03 N



## Relative pH-measurement principal

**Differential pH probes** provide values measured against a product-dependent reference parameter. The measured value is therefore a product-specific value (**relative pH measurement**) that allows a statement as to whether a process is performed according to defined specifications. This measured value is therefore ideal for controlling and monitoring recurring batch processes (e. g. formulations without changes) or continuous measurement.

**Differential pH probes** are simple in structure: two ion-sensitive enamels are fused onto a steel probe carrier and form the measuring part of the sensor. One sensor surface responds to H<sup>+</sup> ions and provides a potential that depends only on the pH value; this is called the pH glass.

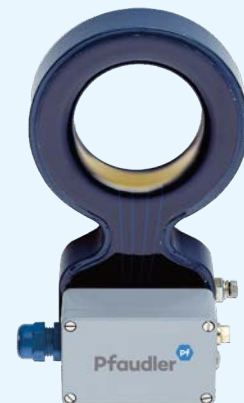
The other sensor surface – the reference glass or reference electrode– responds to the salts dissolved in the liquid, especially the Na<sup>+</sup> ions present, and thus provides a product-specific reference potential. Once the transmitter has been configured with data from the measurement and test report provided, the **pH differential probe** is calibrated in its installed position using a product sample. The probe then works like a “normal absolute” pH measurement device in the specified range. The special relative measurement principle means that the probe functions without an electrolytic liquid. This eliminates the risk of the product being contaminated by the electrolyte and ensures practically maintenance-free operation.



PH-PROBE  
TYPE 18



ROD PH-PROBE  
TYPE 40



RING PH-PROBE  
TYPE 40

# Glass-lined pH Probes

For highest hygienic process standards

In food production, the pH value is an important indicator of consistent quality, taste and reproducibility in a product, and a significant variable during and after cleaning of the production facilities. The compact probe named pH-Reiner was consistently matched to the needs of the foodstuffs, pharmaceutical and biotech industries.

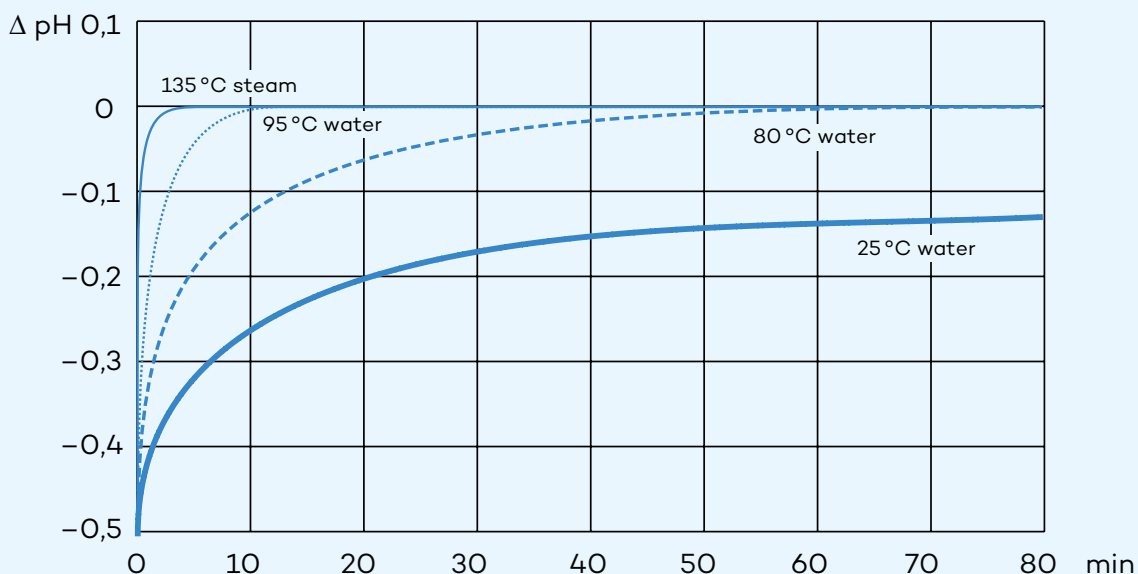
The measuring electrode with a large surface area consists of pH-sensitive glass that is fused on to the lower end of the glassed probe carrier in an annular shape. The area of the measuring electrode is a multiple of that of glass electrodes. Therefore, precision measurements of the pH value can even be carried out in those media in which measurement ceased to be possible using

other methods. In contrast to conventional glass electrodes, the pH glass is in contact with the fluid on one side only. Aging of the probe or measured value drifts are not possible with this probe. The reference electrode necessary for the pH measuring chain is integrated in the probe head. The electrolyte connection between the reference electrode and the product is made using a tube and a shrunk, aseptic ground diaphragm. The electrolyte is contained in a PE bottle that is placed in a stainless steel pressure vessel and the electrolyte bottle can be replaced without affecting sterile conditions. A special, sterile Pfaudler electrolyte is used as a standard. If necessary, infusion solutions such as a sterile saline solution, may also be used as electrolyte. The electrolyte system is pressurized, therefore, the pressure inside the electrolyte system is always higher than the operating pressure inside the reactor or piping. Therefore, no product can enter the probe or contaminate the diaphragm. The pH Reiner probe can be cleaned and sterilized in-line (up to 134 °C) without losing its characteristics.



## Easy to clean

Reconditioning the pH Reiner probe after cleaning with alkali  
Regeneration time (min) After 30min CIP using 2% NaOH at 85 °C



**PH-PROBE**  
TYPE PH-REINER



**ELECTROLYTE  
VESSEL**  
STAINLESS STEEL





# Glass-lined Probes

For highest process standards

## Redox potential measurement

Several variants of our probes are designed for measuring redox potential. Like other Pfaudler measuring probes, these are robust and resistant to attack. Their function is to measure the redox potential arising in oxidation or reduction processes. This measurement is carried out with a noble metal electrode against a reference electrode. There are two different versions to choose from: high-impedance measuring transmitter.

The redox potential is measured between a rhodium electrode embedded in the enamel and a pH enamel reference electrode. The magnitude of the potential occurring at

the reference electrode depends on the pH value of the product. Thus, a redox voltage is obtained which is not dependent on the pH value. The rH measuring probe is chemically highly resistant: the measuring electrode is made of rhodium, the reference electrode of pH enamel.

## The combined measuring probe pH/rH

The combination of both measuring systems on one carrying tube makes possible the simultaneous measurement of pH value and redox potential. The technical data for this combined measuring probe are as for the pH measuring probe type 03 or type 04 and rH type B.



ROD PROBE  
TYPE RH



ROD PROBE  
TYPE PH/ORP



RING PROBE  
TYPE PH/ORP

## Conductivity measurement

In the LF measuring probe, four metal (rhodium) electrodes are aligned longitudinally and fused into the enamel coating of the probe carrier. Thermometer tubes, baffles or spacer rings may be used as probe carriers. The cell constant is dependent on the geometry and location of the probe and cannot be predetermined. For this reason, a fourwire circuit is used. A constant alternating current flows across the two outer electrodes and through the product. The resultant voltage drop is sensed by the two inner electrodes and transmitted to a high-impedance measuring transmitter.



**ROD PROBE  
TYPE LF**



**RING PROBE  
TYPE LF**

# Technical Data

## Product overview

Type	pH 03 N/K/Ring	pH 03 N/Dual	pH Reiner
Measured value	Absolute pH	Absolute pH (2x)	Absolute pH
Reference system	Diaphragm + reference electrode	Diaphragm + reference electrode	Ground-joint diaphragm (ceramics), reference electrode AgAgCl
Measuring range	0 to 10 pH	0 to 10 pH	Linear range 0 to +10* pH / application range -2 to +14** pH
Operating temp.	0 to +140 °C	0 to +140 °C	0 to +140 °C
Temperature compensation	Pt 100	Pt 100	Pt 1000
Operating pressure	-1 to +9 bar	-1 to +9 bar	-1 bis +6 bar
Ex. protection	II 1/2 G EEx ia IIB T6 or II 2G EEx ia IIC T6	II 1/2 G EEx ia IIB T6 or II 2G EEx ia IIC T6	-
Dimensions (mm)	L = 300 – 3200 D = 38 – 180 DN = 50 – 200  Ring-probe***: DN 50 / DN 80	L = 300 – 3200 D = 38 – 180 DN = 50 – 200	L = 120 / D = 12.5
Electrical connection	5-pin, Lemo	5-pin, Lemo	6-pin gold-plated, interconnex Variopin
Degree of protection	IP66 to IP68	IP66 to IP68	IP68
Electrolyte	Special Pfaudler KCL solution	Special Pfaudler KCL solution	Special sterile Pfaudler KCL solution

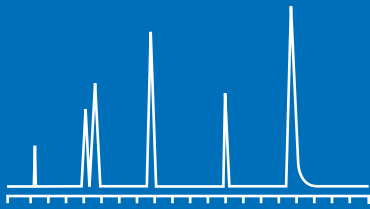
\* depends on temperature

\*\* depends on alkali error

\*\*\* other dimensions on request

\*\*\*\* higher pressure on request





## ANALYTICAL DATA

### ION SENSITIVE pH Value 2.0

	pH 40/pH 40 Ring	pH 18	pH/ORP	rh	LF/LF Ring
	Relative pH	Relative pH	Absolute pH and Redox potential	Redox potential	Conductivity
	Reference enamel	Reference enamel	Diaphragm + reference electrode	Reference enamel	-
	3 to 12 pH	3 to 12 pH	-1200 to +1500 mV 0 to 10 pH	-1200 to +1500 mV	0.01 to 2000 mS/cm
	0 to +140 °C	0 to +140 °C	0 to +140 °C	0 to +140 °C	-25 to +200 °C
	Pt 100	Pt 100 (optional) Pt 1000	Pt 100	Pt 100 (optional)	Pt 100
	-1 to +40**** bar	-1 to +15 bar	-1 to +9 bar	-1 to +40**** bar	-1 to +40**** bar
	II 1/2 G EEx ia IIB T6 or II 2G EEx ia IIC T6	-	II 1/2 G EEx ia IIB T6 or II 2G EEx ia IIC T6	II 1/2 G EEx ia IIB T6 or II 2G EEx ia IIC T6	II 1/2 G EEx ia IIB T6 or II 2G EEx ia IIC T6
	L = 300 – 3200 D = 38 – 180 DN = 50 – 200  Ring-probe***: DN 50 / DN 80	L = 144 D = 31	L = 300 – 3200 D = 38 – 180 DN = 50 – 200	L = 300 – 3200 D = 38 – 180 DN = 50 – 200	L = 300 – 3200 D = 38 – 180 DN = 50 – 200  Ring-probe***: DN 50 / DN 80
	5-pin, Lemo	5-pin, Lemo	6-pin gold-plated, interconnex Variopin	5-pin, Lemo	5-pin, Lemo
	IP66 to IP68	IP66 to IP68	IP68	IP66 to IP68	IP66 to IP68
	No KCL solution is needed	No KCL solution is needed	Special Pfaudler KCL solution	No KCL solution is needed	No KCL solution is needed

# Features and Benefits

## Product overview

Features	pH 03, pH 03 Dual, pH Ring	pH 40, pH 18	pH Reiner	rH, pH /ORP	LF, LF Ring
Mechanical robust, abrasion-resistant, chemically resistant	•	•	•	•	•
Extremely high pressure ranges possible		•		•	•
Suitable for high temperatures	•	•	•	•	•
Self-cleaning	•	•	•	•	•
CIP- / SIP-compliant	•	•	•	•	•
Slope is maintained throughout service life	•	•	•		
Positive pressure effectively prevents diaphragm clogging and contamination	•		•	•	
No reference electrode poisoning possible	•		•	•	
Glass-lined sodium ion sensitive reference electrode without diaphragm and electrolyte line		•			
Stainless steel pressure vessel			•		
Electrolyte in sterile bottle with septum			•		
EHDG certification			•		
Certified for explosion zone 0	•	•		•	•

Benefits	pH 03, pH 03 Dual, pH Ring	pH 40, pH 18	pH Reiner	rH, pH /ORP	LF, LF Ring
Permanent inline monitoring in applications with high mechanical and chemical stress	•	•	•	•	•
No retractable holder / bypass installation required	•	•		•	•
Low life-cycle costs due to minimal maintenance expense	•	•	•	•	•
Service life limited only by glass corrosion and / or abrasion	•	•	•	•	•
No electrolyte contamination of the product		•			•
No need for consumables		•			•
Permanent inline monitoring in hygienic applications			•		
Combined pH / ORP measurement possible				•	
No catalytic or biological effects	•	•	•	•	•
Can be stored dry	•	•	•	•	•



# Global Services Capability



Pfautler guarantees a global service during the whole process, pre and post sales, with the largest service organization in different sectors.

Our Service Centers are close to your site to guarantee fast and flexible services. More than 150 people are at your service. We are present in several countries with field engineers who can provide you with comprehensive support for installation, commissioning and maintenance of your facilities and plants.



## Our Services

From comprehensive engineering and technical services to our rapid, reliable field services and aftermarket parts supply, you can count on us to keep your process system operating properly:

### Engineering

- Consultancy Services
- Pilot testing / toll operation
- Process engineering

### Installation, Commissioning, Start up

- Planning
- Project management
- Installations
- Lining measurement technologies

### Maintenance and aftersales

- Maintenance & repair
- Troubleshooting
- Glass inspection, reglassing and repair
- Shutdown services
- Spare / Replacement parts
- Mechanical seal exchange

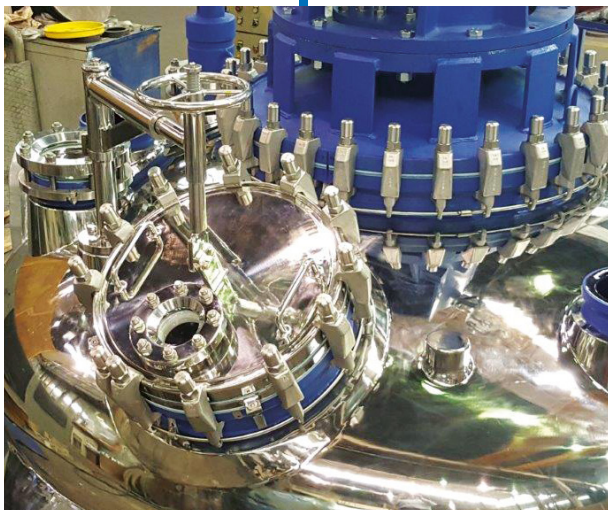
## Pfaunder Safety First

Delivering excellent safety performance is necessary for any company operating in the process industries. Over the years, and all over the world, Pfaunder has provided security in its products and highly-qualified service teams.

We are committed to safety and our field service organization that provides installation and maintenance for your facility, has developed strict safety policies to ensure a safe working environment.

Pfaunder guarantees:

- skilled professionals properly prepared and qualified on security and risk management
- observance of international standards
- use of professional personal protective equipment
- reduced operating risks



## Refurbishing, reglazing and inspection

In addition to its expertise in manufacturing and market products and engineered solutions, Pfaunder has core expertise in the service area of full equipment refurbishing. The reactors are completely reglazed, refurbished combined with a suitable retrofitting of all devices or accessories, producing an appropriate program to meet specific customer needs and timeframes. All this is in compliance with international and European standards. Our technicians provide a complete glass lining inspection program to ensure your reactor is in proper condition for safe and efficient operation.

Our commitment to quality components means that our technologies are often in service for many years. However, our pioneering approach means that during this time we have developed new solutions. Whether your process is changing or you are looking to further optimise performance levels, an upgrade to our new technologies can improve the capabilities of your reactor.

# Worldwide Presence



GMM Pfaudler is a global leader in corrosion-resistant technologies, systems, and services for the chemical, pharmaceutical, food and energy industry.

Our Branded Product Lines that include PFAUDLER, NORMAG, MAVAG, MIXION, INTERSEAL, EQUILLOY and EDLON, showcase our strength as a group, our capabilities, and our pursuit for constant innovation. With an end-to-end solutions-oriented approach, a global footprint, and a perfectly integrated offering system we are able to meet complex industry demands worldwide.

GMM Pfaudler is driven by 1500+ individuals across 4 continents and 14 global manufacturing facilities around the world. The Group's targeted investments in strategic markets, innovation and competitiveness paves the way forward for GMM Pfaudler's continued legacy.

**100**  
Countries

**1500 +**  
Employees

**04**  
Continents

# Our Global Contacts

## Europe

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