HAMILTON

pH Measurement Solutions

Precise Measurement Across Industries

“Innovation for a better world”

The World of Process Analytics
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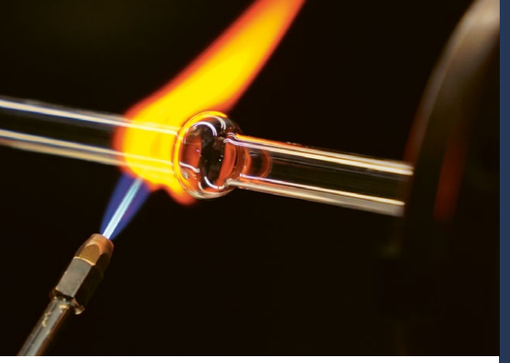
Content



The History of pH at Hamilton

Hamilton Company is a family-owned business. Our journey into Process Analytics started in 1968 when we established Hamilton Bonaduz AG as a base to better serve the European scientific community.

Here, we applied our expertise in glass-making and precise measurements to new markets to establish ourselves as a producer of pH sensors.

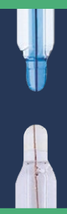
One of our innovations was the invention of a single pore electrode – a single, very narrow, glass channel that is 2000 times larger than conventional diaphragms and provides a direct contact between the reference electrode and sample for better resistance to clogging.

Our first pH electrode launched in 1991, and since then, we have continued to innovate in pH sensor technologies, including polymeric or biocompatible reference electrolytes.

Innovation Highlights

pH Glasses
Measurement Accuracy in Various Applications

Measurement stability and sensor lifetime in various environments requires different pH glasses.
More information on page 9



Biocompatible Reference Electrolyte
Biological risk of cytotoxicity in industrial use

For industries such as biopharma and food, using non-toxic materials is mandatory.
More information on page 10

Pre-Pressurized Sensors
Unidirectional Electrolyte Flow

Guarantees a steady, one-way flow of electrolyte to prevent reference poisoning or coating of the sensor.

Single Pore Concept
The Never-Clog Liquid Junction

For direct contact between the reference electrode and the sample via a single hole that is virtually uncloggable.
More information on page 9

Polisolve Plus
Most Innovative Polymer Reference Electrolyte

Combines the durability of a polymer electrolyte with the Single Pore concept for a pH sensor that is so robust it can withstand a wide range of (difficult) applications.
More information on page 10

OneFerm
Our Best Single-Use pH Sensor on the Market

Available with multiple connectivity options and sensor lengths to work with most single-use bags and bioreactor installations.
More information on page 19

The Importance of pH Measurement

While we can instinctively sense acidity or bitterness in everyday life (like with vinegar or soap water), precise pH measurement is vital for optimal control in various industrial applications that require far greater precision. Potentiometric pH sensors offer accurate and reliable measurement of hydrogen ion concentration in aqueous solutions, enabling precise control for optimal results. Industrial processes rely on precise pH control.

Product Quality and Consistency

pH directly impacts the properties and shelf life of food and beverages, pharmaceuticals, chemicals, and textiles. Maintaining the correct pH ensures consistent product quality.

Process Efficiency and Optimization

Many industrial reactions are pH-dependent. Accurate pH measurement allows for real-time adjustments, maximizing efficiency and minimizing waste.

Environmental Protection

Wastewater treatment relies on maintaining specific pH levels for effective purification and minimizing environmental impact.

Diverse Applications, Precise Control

From food production and metal processing to pharmaceuticals and wastewater treatment, pH measurement plays a critical role in numerous industries. Here are some specific examples:

- **Biopharma:** Precise pH measurement for process control to maximise productivity while maintaining the targeted product quality.
- **Pharmaceutical Manufacturing:** Precise pH measurement for process control to ensure drug stability and effectiveness.
- **Chemical Production:** Controlling reaction rates and product purity in various chemical processes.
- **Water Treatment:** Optimizing water purification processes and minimizing environmental impact in wastewater treatment.
- **Food and Beverage:** Ensuring optimal taste, texture, and shelf life of products like juices, beer, and dairy products.

Common Challenges in pH Measurement

1 

Contamination Risk

2 

Robustness & Drift

3 

Calibration & Accuracy

4 

High Running Cost

5 

Application-specific Solution

Our Solutions

Our glass membrane formulations are compatible with autoclavation, SIP and CIP. The OneFerm Single-Use sensor is also suitable for Gamma irradiation.

Can withstand frequent SIP, CIP and autoclavation cycles with very low drift.

Our DuraCal buffers are available in our pioneering bottle, designed to reduce waste and conserve resources during calibrations by dispensing small volumes of buffer into the self-contained reservoir.

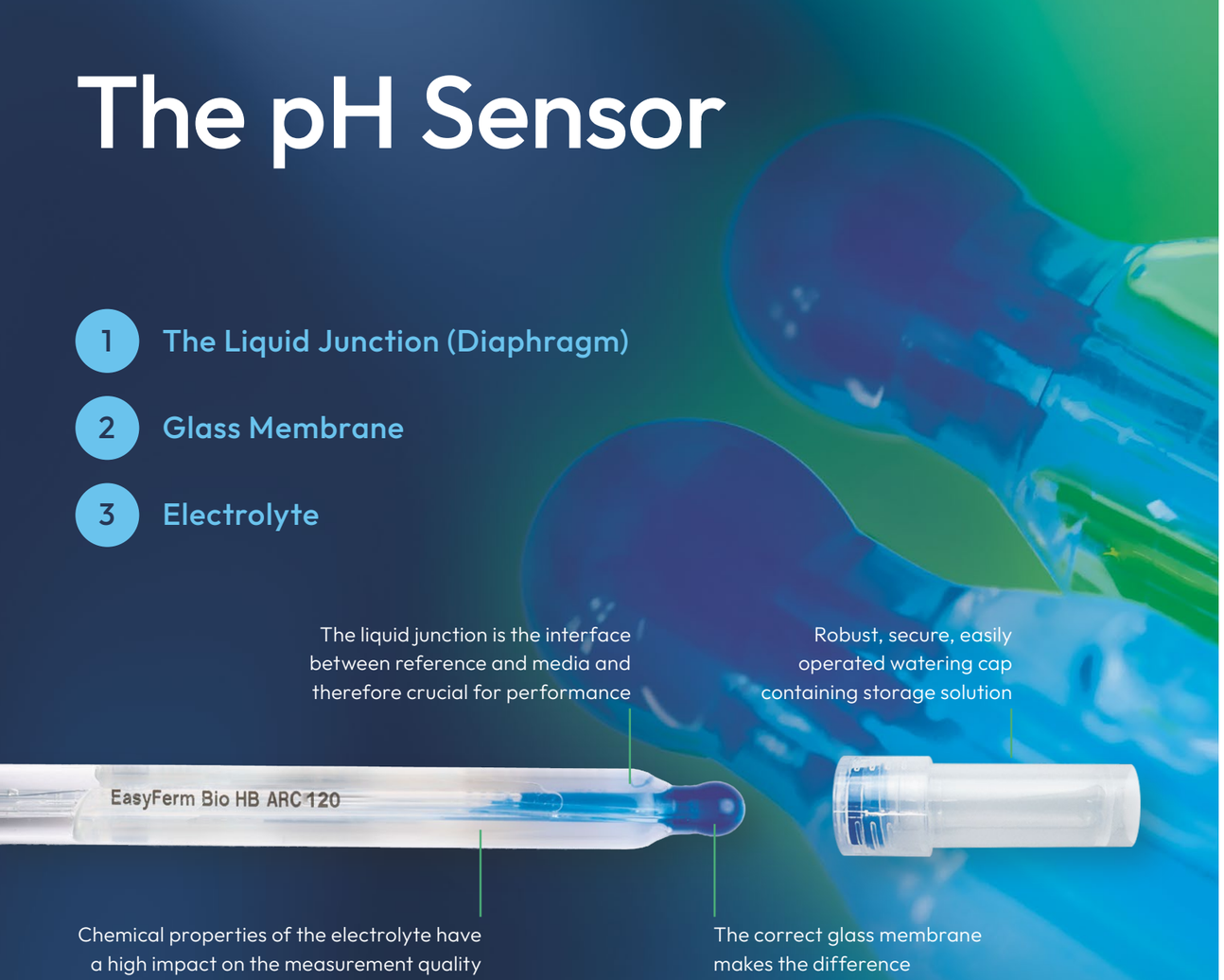
Maintenance time and documentation for the daily running of your processes are reduced with our digital solution – Arc.

See «Arc Intelligent pH Sensors», page 12

We have an extensive knowledge of the best combinations for your applications and can support you to find the right solution for your process.

The pH Sensor

1. The Liquid Junction (Diaphragm)
2. Glass Membrane
3. Electrolyte



Factors Influencing the Selection of a pH Sensor

- Temperature
- pH Range
- Connector
- Chemicals
- Installation
- Conductivity Value
- Pressure
- Communication

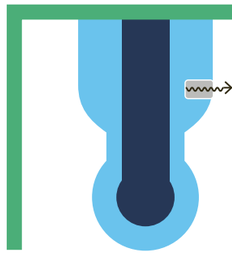
For more information, please check the sensor selection guide in the product catalog.

1 The Liquid Junction (Diaphragm)

The diaphragm or liquid junction is a critical part of the reference electrode. It provides an electrolytic interface between the Ag/AgCl reference system and the measured liquid solution.

There are many different diaphragm designs differing in construction and shape currently available. Each type has its advantages.

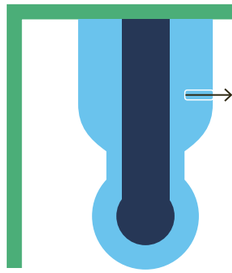
It is normally the measurement application which determines the use of a specific diaphragm design.



Porous Ceramic Diaphragm

Most frequently used liquid junction with high chemical resistance.

- Provides a reproducible electrolyte outflow



Single Pore™ Diaphragm

A constant and reliable leakage of electrolyte for the most accurate and repeatable results.

- Clogging or contamination is practically impossible
- When combined with a polymer electrolyte, it offers the ideal industrial pH sensor

2 Glass Membrane

Hamilton offers a variety of different pH glass membrane formulations which are optimized for specific applications. The selection chart below describes some of the different applications and the glass types which are best suited for them.

Glass type	Suggested applications
PHI	Best lifespan in frequent SIP and autoclavation applications with very low drift. The PHI glass is our recommended membrane glass for bioreactor installations found in R&D, upstream and downstream pharmaceutical applications. Most commonly used with **EasyFerm Plus, EasyFerm Bio, ChemoTrode, FermoTrode, InchTrode (cylindrical membrane)**
HB	Best lifespan in frequent CIP and autoclavation applications. Fastest response time. The HB Glass is our recommended membrane glass for food, beverage, and brewing applications. Most commonly used with **EasyFerm Plus, EasyFerm Bio**
HF	The HF membrane glass formulation is specifically recommended for use in media containing hydrofluoric acid. Most commonly used with **Polilyte Plus, InchTrode (flat membrane), MecoTrode, Polilyte Pro, EasyControl**
H	Provides stable readings in anhydrous or partially aqueous solutions. Low alkali error with good accuracy at high pH or elevated temperature. The H membrane glass works well for most general industrial applications. Most commonly used with **Polilyte Plus, MecoTrode**

3 Electrolyte

The sensor combines the reference electrode and the measurement electrode in a single glass shaft. The glass measurement electrode is well known as the portion of the pH probe which provides varying voltage that relates to changing H_3O^+ concentration within the liquid. The reference electrode is often the lesser understood half of the probe, but is equally important. Choosing the proper reference or electrolyte for the application can greatly help to ensure better pH measurement accuracy and probe longevity.

Polymeric Electrolyte

Semi-solid plastic-like material that embeds the KCl electrolyte within the polymer. This polymer is immibile and therefore very difficult for process liquid to ingress into the reference and affect the measurement.

Electrolyte

- Polisolve

Sensor

- Polilyte Plus
- Polilyte Pro
- Polyplast
- InchTrode

Liquid Electrolyte

Liquid electrolytes are commonly used with flowing reference (or refillable) sensors, which rely on a steady flow of electrolyte through the reference system out throught the diaphragm and into the sample.

Electrolyte

- 3M KCl

Sensor

- ChemoTrode
- IonoTrode

Viscous Electrolyte

Viscous KCl based electrolytes prevent the electrolyte from flowing to fast out of the electrode also at higher temperature. Therefore the lifetime of the sensor is prolonged.

Electrolyte

- Viscous KCl electrolyte
- Foodlyte
- Phermlyte

Sensor

- EasyFerm Bio
- EasyFerm Plus
- MecoTrode
- Liq-Glass PG

Connectivity Options

Cables

A high quality measurement requires a high quality connection to the process control system. Hamilton cables ensure the best possible connection between your sensor and your process control system. Below are a list of connectors available with Hamilton pH sensors.

Easy to connect with our new connector

VP

The VP (VarioPin) is a common connector used throughout the Hamilton sensor product portfolio. VP is abbreviation for “VarioPin”. The VP designation often includes a number referring to the number of exposed contact pins. The autoclavable and hygienic design makes it perfect for biopharma applications.

K8

K8 connectors are typically used on traditional pH / ORP sensors which lack temperature compensation. These connectors have a two pole design comprised of the center core and outer metallic threaded connection.

S7/S8

S7 and S8 connectors are typically found on traditional pH sensors with no temperature compensation. They are the same basic design however S8 connectors have PG13.5 mounting threads, while S7 connectors do not. These connectors are recessed thus care must be taken to avoid moisture getting trapped which could lead to a short circuit.

Memosens

Memosens® signals are digitalized and transferred inductively via a non-contact connection. Memosens features complete galvanic isolation and is fully waterproof and resistant to environmental influences.

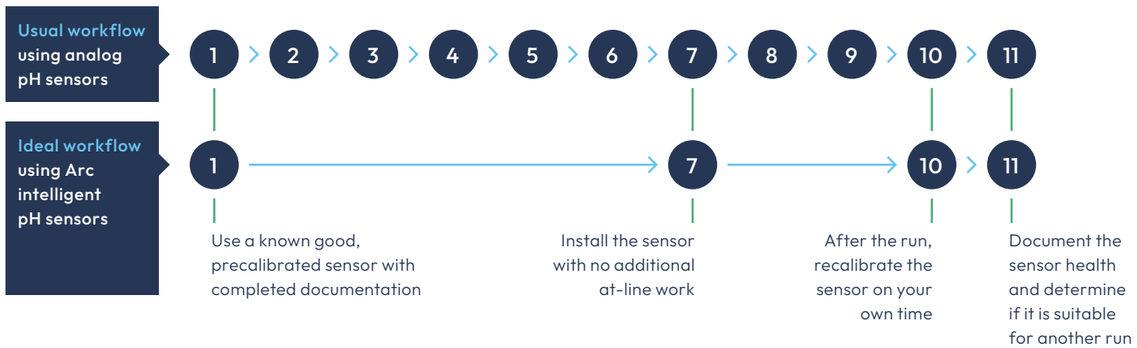
Transmitter

Elevate Your Process Monitoring with the Hamilton H110 Transmitter

Achieve precision and reliability with the Hamilton H110 transmitter, engineered for diverse industrial applications. Perfect for biopharmaceuticals, pharmaceuticals, water and wastewater treatment, and chemical processing, the H110 ensures accurate, real-time data for maintaining optimal conditions and meeting regulatory standards. With dual-input capability, simultaneously measure pH, ORP, conductivity, and oxygen – streamlining your process analytics. Its robust design, user-friendly interface, and exceptional reliability make the H110 the ideal choice for enhancing process efficiency and operational control.

Arc Intelligent pH Sensors

Traditional analog pH sensors require laborious multi-step workflows that are often far from the ideal workflow. In contrast, Arc intelligent pH sensors significantly simplify the workflow and enable automated documentation.

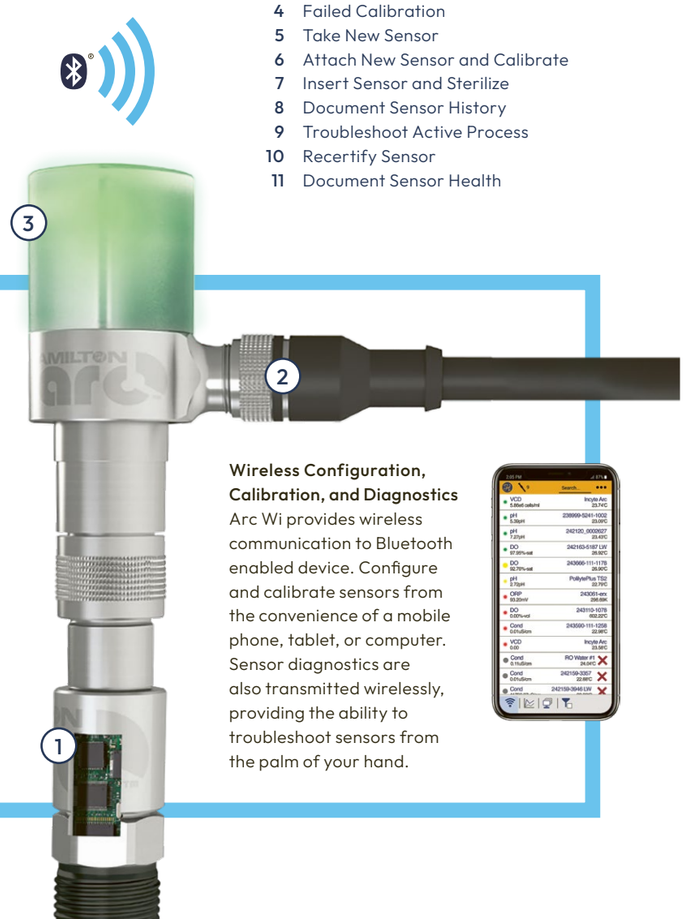


Implementation of intelligent sensors, like Arc pH, can help to streamline steps for process measurement with the added capability for monitoring and recording the sensor's health throughout.

Anatomy of an Arc Sensor

Arc's integrated microtransmitter amplifies sensor signal for direct connection to the control system. Sensor configuration and calibration occur via USB or wireless Bluetooth®.

1 Take Sensor
2 Collect Buffers
3 Attach Sensor and Calibrate
4 Failed Calibration
5 Take New Sensor
6 Attach New Sensor and Calibrate
7 Insert Sensor and Sterilize
8 Document Sensor History
9 Troubleshoot Active Process
10 Recertify Sensor
11 Document Sensor Health



① **Arc Microtransmitter**
Arc sensors save space and cost with their integrated microtransmitter. Calibration and diagnostic data is saved within the sensor, allowing for more reliable in-lab calibration.

② **Hardwired Process Control Data**
Arc sensors provide a robust connection directly to the Process Control System. A wide array of analog and digital communication protocols allows effortless integration into existing systems (4-20 mA, Modbus, Profinet, OPC UA).

③ **Arc Wi Adapter (optional)**
Arc Wi Adapters enable wireless communication from the sensors to the ArcAir application without interrupting the hardwired signal. An LED in the adapter provides visual indication of sensor status:

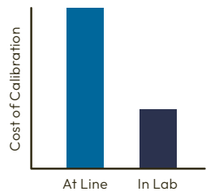
- Active BT Connection
- Sensor Warning
- Normal Operation
- Sensor Errors

Wireless Configuration, Calibration, and Diagnostics
Arc Wi provides wireless communication to Bluetooth enabled device. Configure and calibrate sensors from the convenience of a mobile phone, tablet, or computer. Sensor diagnostics are also transmitted wirelessly, providing the ability to troubleshoot sensors from the palm of your hand.

Benefits of Replacing Analog with Intelligent Sensors

No need for separate Transmitters

Reduced Calibration Costs



Automated Documentation

Up to **66%** Lower Calibration Costs

Up to **89%** Lower Maintenance Costs

Up to **80%** Lower Documentation Costs

Up to **76%** Lower Start-up Costs

- Controlled Laboratory Environment
- Mobile Diagnostics
- Batch Calibration
- Status Light
- Take and go to Sensor Installation
- Sensor Quality Indicator
- Automatic Report Generation
- Connect Directly to the PCS
- User Security Roles
- Eliminate the Transmitter (4-20 mA/Modbus®)
- Sensor Cloning

Using our converter portfolio compatible with:
Profibus®
Profinet®
Foundation Fieldbus®
ECS (mV)

Example based on Hamilton pH Arc Sensors

pH Sensor Portfolio Overview

Sensor	Feature	Biopharma				Chempharma	Cultivated Meat	Brewery and Beverages		Food and/or Industrial processes	Harsh industrial applications	Waste water treatment	General water applications
		Single-Use	Upstream	Downstream	Cleaning (CIP) Water treatment			Brewing Fermentation Storage	Cleaning equipment, CIP and water treatment				
OneFerm pH	Dry Storage / Low Drift	✓											
EasyFerm Plus	Designed for hygenic applications (autoclavable, CIP and SIP)		✓ (PHI)							✓ (PHI, HB)			
EasyFerm Bio	Designed for hygenic applications (autoclavable, CIP and SIP)		✓ (PHI)	✓ (PHI)			✓ (PHI)	✓ (PHI, HB)		✓ (PHI, HB)			
Polilyte Plus	Designed for low conductivity measurements and strong acids, bases and solvents				✓	✓ (H)			✓	✓ (H, HB, PHI)	✓ (PHI)	✓ (HF)	✓ (HF)
MecoTrode	Designed for extreme pH values and temperature				✓	✓ (H)				✓ (H)		✓ (HF)	✓ (HF)
ChemoTrode	Designed for hygenic applications					✓				✓	✓		
InchTrode	Designed to withstand demanding applications					✓					✓	✓	✓
IonoTrode	Designed for very low conducitvity measurements												✓
Polilyte Pro	Designed to perform maintenance free in water applications											✓	✓
Polyplast	Designed to perform maintenance free in water applications											✓	✓
EasyControl	Entry level process sensor for chemical and waste water applications											✓	✓
Liq-Glass PG	Entry level process sensor for chemical and waste water applications											✓	✓

EasyFerm Bio

The Foodlyte electrolyte of the EasyFerm Bio sensors is Certified for bio-compatibility, making it the ideal choice for Food or Biopharma applications. Different glass membrane formulations are suitable for different applications, allowing the user to optimize their processes. Hamilton's clog-free diaphragm increases the stability and accuracy of readings, while increasing the lifetime of the sensor.

Benefits

- Pre-pressurized reference design for accurate pH measurement
- Clog-free diaphragm ensures extremely low drift over the sensor's lifetime
- Customizable to your application

Typical applications

- Certified bio-compatible – suitable for biopharma, food and beverage applications

EasyFerm Plus

The EasyFerm Plus with the different glass membrane formulations are suitable for different applications, allowing the user to optimize their processes. Pairing Hamilton's Phermlyte electrolyte with a pre-pressurized reference and their clog-free HP Coatramic diaphragm increases the stability and accuracy of readings, while increasing the lifetime of the sensor.

Benefits

- Pre-pressurized reference design for accurate pH measurement
- Clog-free diaphragm ensures extremely low drift over the sensor's lifetime
- Customizable to your application

Typical applications

- Suitable for most industries

Polilyte Plus

The Polilyte Plus sensors are designed for harsh industrial conditions, ensuring maintenance-free operation with anti-clog liquid junctions and reliable accuracy in various solutions. It features an Everef-L reference cartridge for an extended lifespan and integrates Liquid Earth in the VP version for stable signals and enhanced diagnostics.

Benefits

- Maintenance-free design: elimination of clogging with two single pore junctions
- Good performance in highly alkaline solutions and in samples with low conductivity

Typical applications

- Demanding industrial applications in chemical, petrochemical, process water, and wastewater treatment

MecoTrode

The MecoTrode pH sensors are designed for processes in the chemical industry with extreme pH values. They are constructed from a H-glass type membrane which provides a low alkaline error and stable measurement even at high temperatures. Three high-performance ceramic diaphragms reduce the effect of flow potential in viscous liquids.

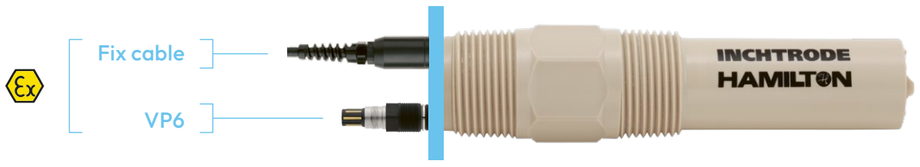
Benefits

- Capable of measuring a broad range of pH (including extreme pH values)
- Stable and accurate pH readings, even at high temperatures
- Low maintenance

Typical applications

- Chemical processes with extreme pH ranges

InchTrode



The InchTrode sensors are designed to measure pH in demanding applications in the paper making and chemical industries. The Single Pore liquid junction guarantees the best and fast measuring results because of the direct contact between the sample and the Polisolve electrolyte. The InchTrode sensors are easy to install without additional housing and have a robust PEEK shaft.

Available in two sizes with two membrane shapes
A-length: 143 or 15 cm
Membrane shape: Flat or Cylindrical

Benefits

- Single Pore for direct sample contact with Polisolve electrolyte – no clogging
- Very long-lasting reference system
- Robust PEEK shaft
- Simple installation without additional housing

Typical applications

- Pulp and Paper industry
- Water and Wastewater

ChemoTrode / P

This is our most robust sensor, designed for measuring pH in demanding applications in pharmaceutical and chemical industries. The Everef-F reference cartridge ensures that the reference electrolyte remains free of silver and precipitation, while the liquid electrolyte can be easily refilled and pressurized up to 6 bar through a port in the sensor for easy maintenance. Refillable liquid electrolyte ensures fast response times and high precision during measurements.

*ChemoTrode / ChemoTrode P, **ChemoTrode

Benefits

- Robust sensor suitable for applications in pharmaceutical and chemical industries
- Liquid electrolyte ensures fast response time and high precision
- Everef-F reference cartridge extends electrode lifetime by preventing diaphragm clogging

Typical applications

- Suitable for chemical processes with extreme pH ranges

IonoTrode

The IonoTrode sensor is designed for applications in ion-weak media and high purity water measurements. The F glass membrane has a very low resistance, therefore the sensor can be used in samples with low conductivity, where it offers the highest accuracy over a long period of time. There is a storage container with 3 M KCl attached via a tube to the side-arm of the IonoTrode and the flow-out of the electrolyte can be controlled with the sleeve diaphragm.

Benefits

- Refillable pH sensor - removable PTFE sleeve diaphragm to check electrolyte outflow
- Robust - the highest accuracy over a long period of time
- Stable measurements in samples with low conductivity of at least 0.2 µS/cm

Typical applications

- Suitable for high purity water measurement

Single-Use pH Sensor

OneFerm

The electrolyte of the OneFerm sensor is certified for bio-compatibility, making it the ideal choice for food or biopharma applications. Hamilton's pH glass together with a clog-free diaphragm increases the stability and accuracy of readings, while maintaining a long dry storage lifetime and suitability for gamma sterilization. Delivered ready to use - the OneFerm sensor is installed into single-use containers and pre-calibrated. Effortlessly integration options in various bioreactors.

Benefits

- Certified bio-compatible
- Ready to use with a short wet-in time
- A suitable pH glass for single-use applications together with a clog-free diaphragm ensures extremely low drift over the sensor's lifetime
- Reliable measurement comparable to proven electrochemical pH sensor technology

Liquid Solutions

DuraCal pH Buffer

DuraCal Buffer pH are pH calibration solutions available in a wide range of independently verified pH values (pH 1.68 - pH 12). Their high buffering capacity accurately provides rapid and stable calibration (± 0.01 pH). Hamilton's pH calibration solutions are stable for up to 5 years and their unique bottle design when buying smaller volumes of buffer (<500 mL volume) ensure convenient calibration with minimal waste (15 mL per calibration) and contamination. Our buffer standards are available to purchase in 250 mL, 500 mL, 5 L, 10 L volumes, therefore have applications from individual lab-scale calibration all the way to automated pH calibration.

Cleaning Solution Set

Complete solutions package: Simple two-solution cleaning kit with storage solution included. Compatible with all glass membrane pH sensors. Our two-solution cleaning simplifies cleaning of glass membrane pH sensors and includes storage solution for comprehensive sensor maintenance.

Storage Solution

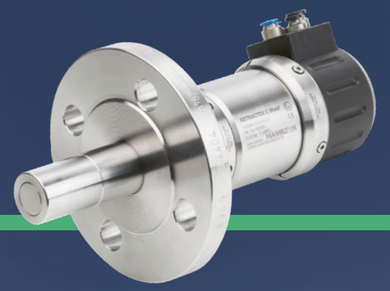
Hamilton storage solution is recommended to increase sensor longevity when not in use. The liquid solution is acid-buffered to prevent any biological growth.

Housings

Talk to us about your process, so that we can help to identify the ideal Housing for your application.

Retractex

Retractex is a retractable housing available in various designs tailored to meet the needs of chemical or biological applications. Retractable housings make it possible to remove the sensor while the process is still running. This provides the convenience to clean or calibrate the sensor without interrupting the process and further the possibility to extract the sensor during particularly intense processes, offering maximum protection for the sensor. It is available in both manual and pneumatic versions made from either steel or plastic (choice of three different plastics).

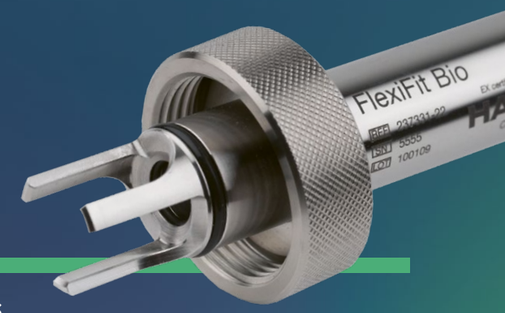


Benefits

- Extremely compact design
- Integrated safety concept – no sensor – no insertion
- Userfriendly installation and maintenance

FlexiFit

The FlexiFit housings are designed for 120 mm sensors in different kinds of industries. A variety of process connections ensure the usability in the chemical industry as well as in hygienic processes. All FlexiFit have EPDM o-rings and the electropolished surface quality (Ra < 0.4 µm) is shown on a certificate. They are suitable for autoclavation, CIP and SIP procedures.

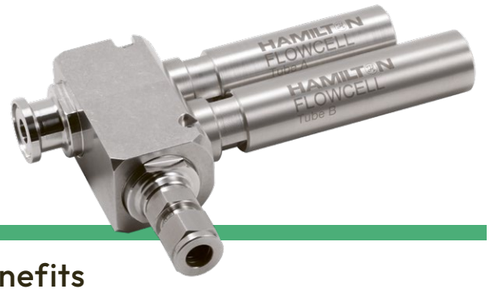


Benefits

- Easy integration for PG13,5 sensors in various stainless steel tanks or pipes
- Optimal sensor postioning for best measurement performance
- 185 versions (connection, insertion length, angeled, o-ring position, sensor protection) to meet all the requirements of process connections

FlowCell

The flexible and space saving design of the FlowCell permits the simultaneous measurement of one or two parameters, even in systems with small pipe dimensions or when in-line measurement is not possible or desired, as samples are bypassed into the FlowCell for measurement. Two sizes of FlowCells are available, each configurable with various pipe connections.



Benefits

- Flexible design: measure one or two parameters simultaneously
- PEEK lining delivers high chemical resistance
- Low dead volume and self draining

Hygienic Socket

The Hygienic Socket with its space saving design and simple sterilization is ideal to weld in fermenters, tanks or small pipes for applications in biopharma, food, beverage, water, pharmaceutical and chemical industries. A sophisticated installation system compresses an o-ring upon insertion, guaranteeing a hygienic seal. The Hygienic Socket offers maximum safety while simultaneously reducing costs due to streamlined o-ring replacement. Two “Live Guard” openings provide an indication of sealing failures.

Benefits

- Patented, hygienic and safe sealing principle
- Flexible housing positioning for best measurement performance
- Easy and time saving o-ring replacement

Services

We offer various field service options to fit your facility’s needs. Our Field Service Team is factory trained and ready to help you at any stage, from installation to long-running maintenance. See which Hamilton field service fits your needs.

Installation Support: Installation, set-up, and calibration support directly on-site. Our field service team ensures your sensors and cables are installed and functioning correctly.

Qualification IQ/OQ: Support for the installation qualification (IQ) and operational qualification (OQ) of Hamilton equipment including complete documentation. Readying your process for GMP manufacturing.

Maintenance and Calibration Services: Preventative maintenance and regular service contracts. Schedule on-site service dates to ensure your sensors are properly maintained and your process is optimized.

On-site Training: User and on-site training for technicians. Tailored training ranging from basic operation to advanced calibration and maintenance.

Learn More: hamiltoncompany.com/field-services

Unlock the Secrets of Bioprocessing Excellence

Download and find out more...

Liquid Solutions Brochure
Hamilton’s pH buffer standards

pH Measurement Guide
Gain a comprehensive under-standing of the fundamentals of pH measurement

Application Notes
See how our customers apply pH measurement to their processes

pH Knowledge Base
Discover articles answering common questions on pH

Process Analytics Catalog
See the full range of products at Hamilton Process Analytics

What Our Customers Say

The Hamilton Polylite Plus H MS 225 pH electrodes have been used in wet flue gas scrubbing in combustion lines 1 and 2 for around 10 years. The electrodes have proven themselves very well in use, they are very reliable and can be changed quickly thanks to the Memosens technology. The service life is approx. 1-1.5 years per electrode.

Thomas Zoller
Klärwerk Karlsruhe

Hamilton pH sensors are characterized by their high measuring accuracy and long service life. This contributes significantly to the control of our processes. They also help us to guarantee the required product quality and to further optimize processes.

Felix Colin
Bioprocess Engineer
AB Enzymes GmbH

HAMILTON

● Headquarters / Manufacturing

Years of Experience
75+

Locations Worldwide
22+

Employees Internationally
3,000+

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