



Cat. No. 51935-88

sensioTM

Gel-filled pH Electrode

Models 51935-00, 51935-11, 51935-22

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Specifications

Specifications are subject to change without notice.

Electrode Type

pH combination with temperature probe

Range

0-14 pH units

Isopotential Point

7.00 \pm 0.5 pH units (0 \pm 29 mV)

Electrode Resistance

250 Mohms at 25 °C (new)

Slope

-58 \pm 3 mV at 25 °C

Temperature Range

Routine Use—0 to 45 °C (32 to 113 °F)

Occasional Use—0 to 100 °C (32 to 212 °F)

Storage

-40 to 50 °C (-40 to 122 °F)

Reference Half Cell

Ag/AgCl

Dimensions

Tip Diameter—12 mm (0.472 inches)

Total Length—152.4 mm (6 inches)

Cable Length—0.91 m (36 inches)

Cable Connector

- *sension* 5-pin Connector (Cat. No. 51935-00)
- Hach One[®] Meter Series BNC & 3.5 mm Phone Connector (Cat. No. 51935-11)
- EC Series BNC & DIN Connector (Cat. No. 51935-22)

Safety Precautions

Please read this entire manual before unpacking, setting up, or operating this instrument. Pay particular attention to all danger and caution statements. Failure to do so could result in serious injury to the operator or damage to the equipment.

To ensure the protection provided by this equipment is not impaired, do not use or install this equipment in any manner other than that which is specified in this manual.

Use of Hazard Information

If multiple hazards exist, this manual will use the signal word (Danger, Caution, Note) corresponding to the greatest hazard.

DANGER

Indicates a potentially or imminently hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION

Indicates a potentially hazardous situation that may result in minor or moderate injury.

NOTE

Information that requires special emphasis.

Precautionary Labels

Read all labels and tags attached to the instrument. Personal injury or damage to the instrument could occur if not observed.



This symbol, if noted on the instrument, references the instruction manual for operational and/or safety information.

Section 1 Introduction

1.1 Electrode Description

The *sensⁱon*[™] Gel-filled pH Electrode (*Figure 1*) is a reliable electrode designed for general purpose pH measurement.

Figure 1 *sensⁱon* Gel-filled pH Electrode

Gel-filled pH Electrode with temperature probe, 5-pin connector for use with *sensⁱon*[™] pH meters (Cat. No. 51935-00)

Gel-filled pH Electrode with temperature probe, BNC & 3.5 mm connector for use with Hach One[®] pH meters (Cat. No. 51935-11)

Gel-filled pH Electrode with temperature probe, BNC & DIN connector for use with EC series pH meters (Cat. No. 51935-22)

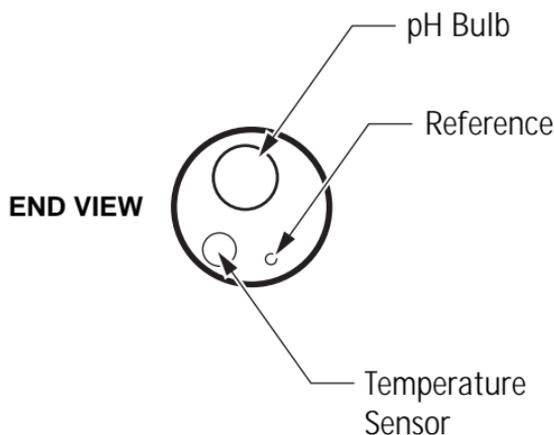


The *sensⁱon* Gel-filled pH Electrode uses a silver/silver chloride reference element with a glass frit junction and a full-range pH glass that can be used in a wide variety of applications, especially at extreme levels of pH. If using the *sensⁱon* System, the meter will automatically account for buffer temperatures during calibration and factor the information into the reported pH. The Auto Buffer Recognition/Auto Temperature Compensation calibration program built into *sensⁱon* meters contains accurate pH profiles for buffers of pH 4.01, 6.86, 7.00, and 10.01 at temperatures from 0 to 60 °C.

1.2 Electrolyte Description

The reference electrolyte in this non-refillable pH electrode is a low viscosity gel that slowly diffuses through the porous reference junctions (*Figure 2*). The gel is saturated with potassium chloride (KCl) and silver chloride (AgCl₂). Additional KCl crystals are added to the electrode during manufacture to offset losses through diffusion and maintain KCl saturation during the lifetime of the electrode.

Figure 2 Electrode End View



1.3 Conditioning the Electrode

When a pH bulb is immersed in an aqueous solution, a hydrated layer slowly forms at the glass/liquid interface. The formation characteristics of this layer depend upon the type of glass, the age of the glass, the previous usage history of the glass, the

temperature and ionic strength of the aqueous solution, etc. This hydrated layer affects the sensing properties of the bulb (charge transfer, and ion transport). A dry bulb will not function.

To ensure the full development of the hydrated layer, electrodes should be conditioned for several minutes in a solution comparable to the sample in terms of pH and ionic strength.

Normal Conditioning

(For routine measurements in samples of moderate to high conductivity, approximately 150 μS and greater):

Initial use: During shipping, the electrode is kept hydrated by a cotton/wool ball saturated in a pH 4.00 buffer/KCl solution. The electrode and saturated ball are encased in a protective vinyl cap. Before using the electrode, remove the cap and soak the electrode tip in a pH 4.0 or pH 7.0 buffer. If the cotton ball is saturated, the electrode will be hydrated after several minutes in the NIST standard. If the cotton ball and electrode are dry, the bulb typically requires soaking in the standard for 30 minutes before becoming hydrated.

Between uses: Between sample measurements of medium to high conductivity, store the electrode in Hach Electrode Storage Solution, a pH 6.35/1.7 M KCl buffer solution. The solution keeps the bulb hydrated and prevents the reference gel from solidifying in the reference junction. Hach electrode storage solution is available in powder pillow form for dilution with deionized water or as a prepared solution.

1.4 Measuring Hints

These suggestions will improve the accuracy of your calibration and sample measurement.

- Allow the potential to stabilize completely (<1 mV/minute drift) before accepting a calibration point or sample reading. Meters set to higher resolutions will take longer to stabilize than meters set to lower resolutions.

- Use calibration standards and samples that are at the same temperature to improve accuracy.
- Use fresh calibration standards to achieve greater accuracy.
- Thoroughly rinse and blot the electrode dry between sample measurements or rinse with small volumes of sample or deionized water.
- Measure samples within a short period of time after collecting. Weakly buffered alkaline solutions can absorb carbon dioxide causing downward drift of pH readings. Cover samples if necessary.
- A multi-point calibration will ensure more accurate measurements than a single point calibration.

1.5 Checking the Slope

After calibrating the electrode with fresh buffer, check the slope using the *sensION* meter's calibration review option. A slope of 58 ± 3 mV indicates a properly functioning electrode.

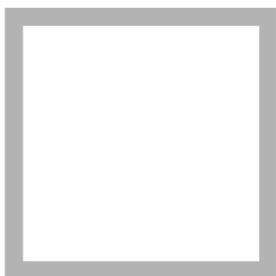
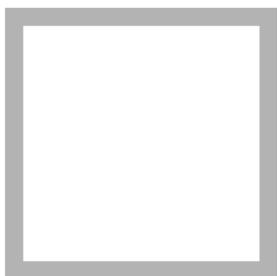
1.6 General Applications

Section 2 describes a general application for the Gel-filled pH Electrode. Specific applications include:

- Water and wastewater treatment to monitor influent and effluent quality.
- Agricultural applications including soil, fertilizer, food, and feed.
- Chemical and biological research.
- Industrial processes in the manufacture of foods, beverages, pharmaceuticals, dyes, photographic film, plating, and chemicals.
- Continuous sampling in aqueous samples up to 45 °C and intermittently in aqueous samples up to 100 °C.

For information regarding applications not described in this manual, contact Hach Technical and Customer Service.

Section 2 Applications



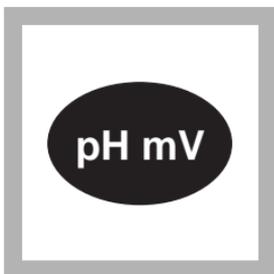
(sensors 2, 3, & 4 meters)

pH, Water and Wastewater (above 150 $\mu\text{S}/\text{cm}$)



1. Connect the electrode to the *sensION2* pH/ISE meter.

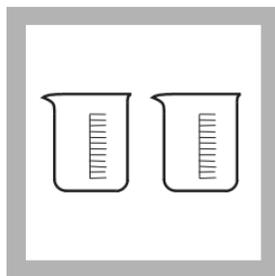
Note: Ensure that the electrode has been conditioned according to instructions in Section 1.3 on page 10.



2. Turn on the meter by pressing **I/O**. Press **PH MV** until the display shows **pH**.



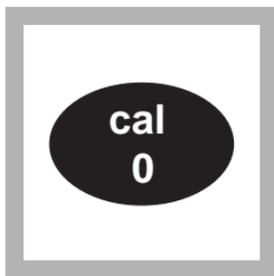
3. Press **SETUP**. Press the up arrow three times. Press **ENTER** to move to the desired number of decimal places, then **EXIT** to leave setup.



4. In two 50-mL beakers or cups, prepare buffers of 4.0 and 7.00 pH or 7.00 and 10.0 pH.

Note: The sample pH should fall within the range of the calibration buffers.

*Note: pH 6.86 buffer may be used instead of pH 7.0. Autobuffer recognition for either pH 6.86 or 7.0 is user selectable in the **sens^{ion}** meter setup function.*



5. Press **CAL**. The display will show: **Standard 1?**



6. Rinse electrode in deionized water and blot dry.



7. Place the electrode in pH 7.0 buffer. Press **ENTER**. The display shows:

Stabilizing...

*Note: Temperature variation causes changes in buffer pH. Hach sens*ion* meters correct for these changes during calibration when using buffers of pH 4, 6.86, 7, and 10.*



8. When a stable pH is determined, the display will show **Standard 2?**. Remove the electrode from the cup. Rinse and blot dry.

Note: The meter will select a stable reading using default meter parameters and the specified resolution. To override the default meter parameters, see the meter manual.

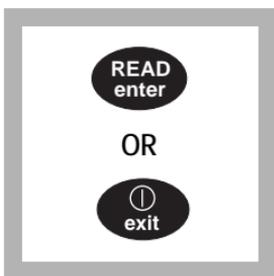


9. Place the electrode in the 4.0 (or 10.0) pH buffer. Press **ENTER**.



10. After the last calibration point has stabilized and the display reads **Standard 3?**, press **EXIT**.

Note: For a three-point calibration, repeat steps 9-10 with an additional buffer.



11. The display will show **Store?**. Press **ENTER** to store the calibration or **EXIT** to leave the calibration mode without storing the values.



12. Rinse the electrode with deionized water followed by a small amount of sample and blot dry.



13. Place the electrode in the sample.



14. Store or record the pH and temperature readings when they stabilize.

Sampling and Storage

Collect samples in clean plastic or glass bottles. Fill completely and cap tightly. Cool to 4 °C and determine pH within six hours. If samples cannot be analyzed within six hours, report the actual holding time with the results.

Accuracy Check

Checking Electrode Response

An electrode is responding properly if its calibration slope is 58 ± 3 mV per pH unit.

Checking Calibration Accuracy

Returning the electrode to a calibration buffer and determining the pH provides a good test of the system. Rinse and recondition the electrode before measuring subsequent samples.

Checking the Precision of the Sample Reading

When practical, measure the pH of the sample several times and report the average pH. *sensION2* meters will store and calculate the average of up to 99 readings.

Method Performance

Precision

In a single lab using an ASTM Substitute Wastewater Standard, specification number D5905-96, and two electrodes with a single *sensION2*, a single operator obtained a standard deviation of 0.005 pH. Each electrode was exposed to seven test solutions with no rinsing in between and with a default stability of 0.5 mV/min.

Interferences

Sodium error may occur in samples with pH 12 or higher. See *Section 4.2* on page 24.

Summary of Method

Water with relatively high conductivity typically has a fairly high buffer capacity. Slight pH changes due to absorption of carbon dioxide are usually not significant. If the sample conductivity is not known and high accuracy is desired, use the Platinum Series pH Electrode and follow either the Low Ionic Strength or high purity method.

The *sensION* Gel-filled pH Electrode responds to the hydrogen ion concentration (activity) by developing an electrical potential. At a constant temperature, this potential varies linearly with the pH of the solution being measured.

pH, Water and Wastewater, continued

REQUIRED REAGENTS AND APPARATUS

Description	Quantity Required		Unit	Cat. No.
	Per Test			
Gel-filled pH Elect. w/Temp., 5-pin.. 1	1		each	51935-00
Gel-filled pH Elect. w/Temp., BNC & 3.5mm1 .			each	51935-11
Gel-filled pH Elect. w/Temp., BNC & DIN1			each	51935-22
<i>sensio</i> 2 Portable pH/ISE Meter/w/elect.1	1		each	51725-10
<i>sensio</i> 1 Portable pH/mV Meter/w/elect.1	1		each	51700-11

OPTIONAL REAGENTS

Buffer, Powder Pillow

pH 4.01, color-coded red.....	15/pkg.....	22269-95
pH 6.86	15/pkg.....	14098-95
pH 7.00, color-coded yellow.....	15/pkg.....	22270-95
pH 10.00, color-coded blue.....	15/pkg.....	22271-95
Singlet pH Solution, pH 7 and 10.....	10 each/pkg.....	27698-20
Singlet pH Solution, pH 4 and 7.....	10 each/pkg.....	27699-20
Singlet pH Solution, pH 4.....	20/pkg.....	27700-20
Singlet pH Solution, pH 7.....	20/pkg.....	27701-20
Singlet pH Solution, pH 10.....	20/pkg.....	27702-20
Singlet pH Solution,Rinse Solution	20/pkg.....	27703-20
Buffer Solution, pH 4 (red)	500 mL.....	22834-49
Buffer Solution, pH 7 (yellow)	500 mL	22835-49
Buffer Solution, pH 10 (blue).....	500 mL	22836-49
pH Storage Solution Powder Pillows.....	20/pkg.....	26573-64
Water, deionized.....	4 L.....	272-56

OPTIONAL APPARATUS

Sample Bottles

General Purpose with Screw-cap,

polypropylene, 500-mL.....	each.....	27581-10
Cleaned and Certified, HDPE,		
for EPA reporting, 500-mL.....	each.....	27582-10

Section 3 Electrode Maintenance

The *sension*[™] Gel-filled pH Electrode has been designed to give trouble-free use, but requires careful handling to extend longevity. This section presents methods of storing and cleaning the electrode.

3.1 Storing the Electrode

Proper electrode storage requires different approaches based on how long the electrode will be stored, how quickly the electrode needs to be used, and the type of sample being measured. Storage affects the reference electrolyte gel, the Ag/AgCl reference element, and the pH sensing glass bulb.

Intermittent storage: Between uses, store the electrode in solutions of similar ionic strength and pH to the samples of interest. Carefully rinse the electrode to prevent sample contamination.

Overnight storage: Store the electrode in Hach Electrode Storage Solution to keep the electrode hydrated.

Shelf Storage: For very long-term storage, store the electrode dry. For faster reconditioning in the future, wet the cotton/wool ball located in the vinyl storage cap with storage solution. Place the cap over the electrode. This will help keep the bulb hydrated.

3.2 Cleaning the Electrode

A contaminated glass bulb or fouled electrode may cause slow response times. Clean the electrode only after following the steps described in *Section 5 Troubleshooting* or when the electrode is known to be dirty. Do not clean the bulb more frequently than necessary, or bulb life may shorten. Clean the electrode according to the type of contaminant present:

General contamination—Immerse the electrode tip in 0.1 N Hydrochloric Acid followed by immersion in 0.1 N Sodium Hydroxide and again in 0.1 N Hydrochloric Acid, each for a

Electrode Maintenance, continued

2-minute period. Rinse with deionized water. Soak in deionized water for at least 15 minutes.

Oils and fats—Immerse the electrode tip in a detergent solution such as Alconox™. Use a soft brush or ultrasonic bath if necessary. **Avoid scratching the glass bulb.**

Organic films—Use an appropriate solvent, such as methanol or acetone.

Note: Keep the cable and connector away from dirt, abrasives, and harsh solvents.

If these steps fail to improve electrode response, complete the *Electrode Service Request Questionnaire* on page 29 and contact Technical Support.

Section 4 pH Electrode Characteristics

4.1 Theory of Operation

pH is a measure of the hydrogen ion activity in a solution and is defined as: $-\log_{10} a_{H^+}$ where a_{H^+} is the activity of the hydrogen ion. The 0-14 range of pH measurement is the measurement of a difference in hydrogen ion concentration of 100,000,000,000,000 (1×10^{14}). This means that at pH 0, the hydrogen ion concentration is 1×10^{14} times greater than at pH 14. This also means that the hydroxyl ion concentration at pH 14 is 1×10^{14} times greater than at pH 0.

When the hydrogen and hydroxyl ions are present in equal numbers (the neutral point), the pH is 7. pH values from 0 to 7 are termed acidic and those from 7 to 14 are termed basic. It is important to note that a pH change of one unit (for instance from pH 6 to pH 7) is a factor-of-10 change in hydrogen ion concentration.

The glass membrane of a pH electrode responds to the hydrogen ion activity by developing an electrical potential at the glass/liquid interface. At a constant temperature, this potential varies linearly with the pH of the solution being measured. The change in potential per pH unit is termed the slope of the electrode. The slope of the electrode increases linearly with temperature.

The potential inside the pH glass bulb is fixed by the filling solution, and the reference electrode potential is constant. For these reasons, any change in the potential of the electrode system at a given temperature will be due to any change in the pH of the solution being measured.

Effects of temperature on pH measurements depend on the reference electrode used, pH of the solution within the pH electrode and pH of the test solution. At a certain pH, temperature will have no effect on the potential of the electrode system. This is known as the isopotential point. Also, at some pH level, the system will exhibit no potential. This is known as the zero potential point. Both the isopotential point and the zero potential point are features designed into electrodes. Each electrode is designed so the isopotential and zero potential points are at pH 7 to minimize temperature effects at this

Section 4, continued

calibration point. At 25 °C, an electrode performing at 100% efficiency will decrease by 59.2 mV for every unit increase in pH.

4.2 Sodium Error Interferences

Sodium error occurs at elevated pH values when sodium ions in the sample solution are incorrectly sensed as hydrogen ions by the glass pH bulb. Below pH 12, sodium error is negligible.

The pH sensing bulbs can be optimized for different applications by altering glass composition. This electrode has been designed using a research-grade, full-range glass that is less susceptible to sodium ion error. Accurate pH values (less than 0.1 pH error) will be achieved at up to 100 mM Na⁺ concentrations in the range of 12 to 13 pH units, and up to 50 mM both at 25 °C in samples of pH 14.

In a single lab, using a sample group of three pH sensing half-cells, in a controlled test versus a Standard Hydrogen Electrode, the following results were obtained:

Table 1 Sodium Ion Error

pH	[Na ⁺]	Error
12.1	0.00 M	0.00
12.1	0.01 M	0.01
12.1	0.05 M	0.02
12.1	0.10	0.03
12.5	0.00 M	0.02
12.5	0.01 M	0.02
12.5	0.05 M	0.03
12.5	0.10	0.05
13.7	0.00 M	0.04
13.7	0.01 M	0.06
13.7	0.05 M	0.07

Use the values presented in *Table 1* to correct for sodium error in samples of similar composition. Add the error values listed below to the pH sensed by the electrode.

Section 5 Troubleshooting

Symptom	Cause	Remedy
No response	Electrode is improperly connected to meter.	Check connection.
	If a two-channel meter, is the electrode connected to the displayed channel? (A shorting cap on a channel input will show ZERO on the display.)	Reconnect the electrode to the desired channel or change the displayed channel on the meter.
	Connector is dirty or wet.	<ol style="list-style-type: none"> 1. Inspect both male and female connector. 2. Clean with mild solvents such as alcohol or acetone. 3. Clean and dry with a lint-free cloth or compressed air.
	Reference junction is blocked.	Immerse in hot water or an ultrasonic bath for several minutes.
	pH sensing bulb and reference junction are not in contact with the sample.	Submerge the probe deeper into the sample.
	Cable contains kinks, breaks, loose connectors, etc.	Replace or repair electrode.
	The meter is broken.	<ol style="list-style-type: none"> 1. Try another electrode. 2. Try the other channel. 3. Check and replace batteries, if necessary. 4. Put shorting caps on and see if meter 'zeros'.
	The meter is not set up to read the appropriate connector.	Select the appropriate connector from the meter setup menu (5-pin on <i>sensiON</i> meters).

Troubleshooting, continued

Symptom	Cause	Remedy
Out-of-range response	See "No response", above.	See "No response", above.
	The bulb may be broken.	Replace bulb.
Erratic response	Electrode is not plugged-in to selected meter channel.	Plug electrode into meter channel.
	Extreme external electrical fields are present. (The pH cable, though shielded, can act as an antenna.)	Install a shorting cap on the unused meter terminal. Do not use stirrers in low ionic strength solutions. Avoid static electricity, nearby pumps, power supplies, etc.
	pH sensing bulb and reference junction are not in contact with the sample.	Submerge the probe deeper into the sample.
	The sample chemistry is changing.	None.
	The pH of a LIS solution is changing due to CO ₂ uptake.	Use LIS Chamber Accessory.
	The bulb is cracked, discolored, or contaminated.	If dirty, clean according to <i>Section 3.2</i> on page 21. If cracked, discard electrode.
	The sample container is contaminated.	Use a clean sample container.

Troubleshooting, continued

Symptom	Cause	Remedy
Low slope	Bulb is old.	Replace electrode.
	Bulb is dirty.	Clean according to <i>Section 3.2</i> on page 21.
	Standards are inaccurate.	Make sure standards were entered into meter correctly. Use only NIST traceable buffers. Use fresh buffers. Change buffers frequently.
	History of harsh usage.	Replace electrode.
	Cracked bulb.	Replace electrode.
High slope	Buffers are incorrect.	Use appropriate buffers.
	Incorrect measurement or calibration technique.	Follow procedures described in <i>SECTION 2</i> on page 13.
	Temperature variations in standards.	Keep sample and standards at same temperature.
	Standards contaminated.	Prepare fresh standards.
High offset	Leakage pathway results in stray voltage via internal electrical short.	Return electrode under warranty.
	Reference gel has become diluted or junction is plugged by a clogged frit.	Submerge in hot water or an ultrasonic bath to attempt to unclog the frit. Replace electrode if no improvement occurs.
	Cracked bulb.	Replace electrode.
Sluggish response	Sample is cold and of low ionic strength.	Wait patiently.
	Improper conditioning.	Condition according to <i>Section 1.3</i> on page 10.
	Bulb, guard, and electrode stem are dirty.	Clean according to <i>Section 3.2</i> on page 21.

Electrode Service Request Questionnaire

1. What model of meter is the electrode being used with?
2. What is the complete lot code of the electrode (located on the electrode cable)?
3. What is the date the electrode was purchased?
4. How long has the electrode been in use?
5. What types of samples are being tested?
6. What is the temperature of the samples being tested?
7. How often is the electrode being used?
8. How is the electrode being stored between uses?
9. What is the electrode slope during a typical calibration?
10. If a new electrode, has it been conditioned according to instructions?
11. If the electrode has been in use for awhile, what maintenance has been performed?
12. Describe the suspected problem or failure of the electrode.
13. When calling for telephone support, have your meter, electrode, buffers/standards, and this completed questionnaire near the phone before calling.
14. Did you use Ionic Strength Adjustor in samples or standards?
15. Did you use a low range method for Low Ionic Strength and high purity water samples with conductivity below $150 \mu\text{/cm}$?
16. Is the sample above pH 12 with a high Na^+ concentration?

Glossary

Acid—a chemical compound that contributes hydrogen ions (H^+) to an aqueous solution or causes the pH to be less than 7.0.

Acidic—A solution or system with a pH less than 7.0.

Activity—The measure of work performed by an ion as it moves through a system. The activity is dependent upon the concentration of all ions in the system and the charge associated with the ion.

Alkali—A solution or system with a pH greater than 7.0.

Alkalinity—Capacity of water to accept hydrogen ions (H^+). Indicates presence of carbonate (CO_3^{2-}), bicarbonate (HCO_3^-), and hydroxyl (OH^-) ions.

Anion—A negatively charged ion (i.e., NO_3^- , Cl^-).

Base—A chemical compound that contributes hydroxide ions (OH^-) to an aqueous solution or causes the pH to be greater than 7.0.

Buffer—

1. A compound, mixture of compounds, or solution which, when added to a system, changes pH to a specified, known value.
2. The ability a solution or system to resist change in pH if either an acid or a base is added.

Buffering capacity—A measurement of the amount of acid or base which can be added to a solution before the pH changes.

Cation—A positively charged ion (i.e., NH_4^+ , Ca^{2+}).

Combination electrode—An electrode composed of a reference half-cell and a sensing half-cell. The reference half-cell is the half of the electrode pair that maintains a constant potential

regardless of solution composition. The sensing half-cell develops a potential proportional to solution composition.

Conditioning—The process of preparing an electrode for use by soaking the electrode in a solution with a pH and ionic strength similar to the sample. Conditioning allows the formation of the hydrated layer, necessary for accurate measurements.

Decade—Any two standards with a concentration ratio of 10. For example:

$$\frac{\text{Concentration of the higher Standard}}{\text{Concentration of the lower Standard}} = 10$$

Dilution factor—A numerical value by which results must be multiplied in order to obtain the actual value of the sample. For example, if 1 mL of sample is diluted to 10 mL, then the result obtained must be multiplied by 10 to obtain the value for the sample before dilution.

Electrolyte—A solution made of dissolved ions that is used to facilitate electrical conductance and ionic transport. The composition is usually potassium chloride (KCl), sodium chloride (NaCl), ammonium chloride (NH₄Cl), or ammonium sulfate ((NH₄)₂SO₄).

Free-flowing reference junction—The point on the electrode where reference gel is freely dispensed without obstruction by frits or other materials.

Hydrated layer—A layer that forms at the glass/liquid interface. Chemically similar to the sample being measured (especially in samples of low ionic strength), the formation characteristics of this layer depend upon the type of glass, the age of the glass, the previous usage history of the glass, the temperature and ionic strength of the aqueous solution, etc.

Inert—Does not react with other substances.

Ion—An atom, group of atoms or molecule that is electrically charged as the result of gaining or losing electrons. An ion resulting from the gain of electrons becomes negative (anion), while an ion resulting from the loss of electrons becomes positive (cation).

Ionic strength—A measure of the concentration of any ion in solution, usually expressed in moles per liter.

Occasional use—Infrequent use where the probe is subjected to test conditions just long enough to obtain a proper reading.

pH—A relative numerical measurement of the acidic, neutral, or alkali nature of a solution or system. Mathematically defined as the negative log of the hydrogen ion concentration.

Potential—The capacity of a system to perform work. When two ions of opposite charge are separated by a distance, there is a potential developed from the tendency of the ions to come back together. Each ion exerts work to come back together. The amount of work needed by each ion to come back together is the potential.

Reference element—A silver wire coated with silver chloride, this element develops a constant potential when immersed in an electrolyte such as potassium chloride.

Reference half-cell—Provides a constant voltage against which the pH dependent voltage from the sensing half-cell is compared.

Reference junction—The point on the electrode where reference gel is dispensed.

Routine use—Typical use following regular, frequent routines, but not continuous as with an in-line monitoring process.

Salt—An ionic compound.

Sensing half-cell—Provides a voltage proportional to the concentration of a specific ion in solution.

Siemen—The unit of conductivity equivalent to mho (ohm^{-1}). Conductivity is often expressed as microSiemens per centimeter ($\mu\text{S}/\text{cm}$) and milliSiemens per centimeter (mS/cm) and it is a measure of how readily a sample conducts electricity. More concentrated solutions conduct more electricity and have higher conductivity.

Sodium error (alkaline error)—Occurs in strongly alkaline solutions, generally greater than 13 pH, when concentrations of H^+ are low, and small, positively charged ions such as Na^+ generate potential differences across the pH glass membrane. These differences can result in measurement errors between -0.5 and -1.0 pH.



General Information

At Hach Company, customer service is an important part of every product we make.

With that in mind, we have compiled the following information for your convenience.

How To Order

By Telephone:

6:30 a.m. to 5:00 p.m. MST
Monday through Friday
(800) 227-HACH
(800-227-4224)
By FAX: (970) 669-2932

By Mail:

Hach Company
P.O. Box 389
Loveland, CO 80539-0389
U.S.A.

Ordering information by E-mail: orders@hach.com

Information Required

- Hach account number (if available)
 - Your name and phone number
 - Purchase order number
 - Brief description or model number
 - Billing address
 - Shipping address
 - Catalog number
 - Quantity
-

Technical and Customer Service (U.S.A. only)

Hach Technical and Customer Service Department personnel are eager to answer questions about our products and their use. Specialists in analytical methods, they are happy to put their talents to work for you.

Call 1-800-227-4224 or E-mail techhelp@hach.com.

International Customers

Hach maintains a worldwide network of dealers and distributors. To locate the representative nearest you, send E-mail to intl@hach.com or contact:

In Canada, Latin America, Africa, Asia, Pacific Rim:

Telephone: (970) 669-3050; FAX: (970) 669-2932

In Europe, the Middle East, or Mediterranean Africa:

HACH Company, c/o Dr. Bruno Lange GmbH

Willstätterstr. 11

D-40549 Düsseldorf, Germany

Telephone: +49/[0]211.52.88.0

Fax: +49/[0]211.52.88.231

Repair Service

Authorization must be obtained from Hach Company before sending any items for repair. Please contact the HACH Service Center serving your location.

In the United States:

Hach Company
100 Dayton Avenue
Ames, Iowa 50010
(800) 227-4224 (U.S.A. only)
Telephone: (515) 232-2533
FAX: (515) 232-1276

In Canada:

Hach Sales & Service Canada Ltd.
1313 Border Street, Unit 34
Winnipeg, Manitoba
R3H 0X4
(800) 665-7635 (Canada only)
Telephone: (204) 632-5598
FAX: (204) 694-5134
E-mail: canada@hach.com

In Latin America, the Caribbean, the Far East, the Indian Subcontinent, Africa, Europe, or the Middle East:

Hach Company World Headquarters
P.O. Box 389
Loveland, Colorado, 80539-0389
U.S.A.
Telephone: (970) 669-3050
FAX: (970) 669-2932
E-mail: intl@hach.com

Warranty

Hach warrants most products against defective materials or workmanship for at least one year from the date of shipment; longer warranties may apply to some items.

HACH WARRANTS TO THE ORIGINAL BUYER THAT HACH PRODUCTS WILL CONFORM TO ANY EXPRESS WRITTEN WARRANTY GIVEN BY HACH TO THE BUYER. EXCEPT AS EXPRESSLY SET FORTH IN THE PRECEDING SENTENCE, HACH MAKES NO WARRANTY OF ANY KIND WHATSOEVER WITH RESPECT TO ANY PRODUCTS. HACH EXPRESSLY DISCLAIMS ANY WARRANTIES IMPLIED BY LAW, INCLUDING BUT NOT BINDING TO ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

LIMITATION OF REMEDIES: Hach shall, at its option, replace or repair nonconforming products or refund all amounts paid by the buyer. **THIS IS THE EXCLUSIVE REMEDY FOR ANY BREACH OF WARRANTY.**

LIMITATION OF DAMAGES: IN NO EVENT SHALL HACH BE LIABLE FOR ANY INCIDENTAL OR CONSEQUENTIAL DAMAGES OF ANY KIND FOR BREACH OF ANY WARRANTY, NEGLIGENCE, ON THE BASIS OF STRICT LIABILITY, OR OTHERWISE.

This warranty applies only to Hach products purchased and delivered in the United States.

Catalog descriptions, pictures and specification, although accurate to the best of our knowledge, are not a guarantee or warranty.

For a complete description of Hach Company's warranty policy, request a copy of our Terms and Conditions of Sale for U.S. Sales from our Customer Service Department.



HACH COMPANY
WORLD HEADQUARTERS
P.O. Box 389
Loveland, Colorado 80539-0389
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FAX: (970) 669-2932

FOR TECHNICAL ASSISTANCE, PRICE INFORMATION AND ORDERING:

In the U.S.A. - **Call toll-free 800-227-4224**

Outside the U.S.A. - **Contact the HACH office or distributor serving you.**

On the Worldwide Web - **www.hach.com**; E-mail - **techhelp@hach.com**
