

# Process Electrodes

## A Worldwide Leader in Electrode Manufacturing

Since the beginning of the 1990's Hanna has been a leader in the research & development of pH and ORP electrodes. Today, Hanna is proud to present the latest family of industrial electrodes, the Flat Tip Series, which completes the wide range of Hanna probes for any process application. All Hanna industrial pH and ORP electrodes are combination type, i.e. the reference half cell and the measurement half cell are assembled in the same body.

## Industrial Electrodes and Probes



HI1000/Hi2000 Series



Standard



AmpHel



Flat Tip

## Reference Half Cell

The reference half cell provides a known and stable reference potential. During the normal electrode life span, this potential can vary, possibly signaling the end of the electrode's life.

- **The main causes of reference potential variation are:**
  - Electrolyte contamination
  - Dilution
  - Electrochemical reaction
  - Junction clogging

As a result of many years of experience and electrode testing in industrial applications, Hanna has found the solutions for all these challenges.



## Electrolyte Contamination

The contamination of the reference half cell is linked to the diffusion of external substances into the reference chamber (strong oxidants, reductants, complexing agents).

The combination of Hanna double junction technology with a polymer reference electrolyte, reduces the diffusion process rate and keeps the reference potential stable for long periods of time.

## Dilution

When the reference cell containing concentrated 3.5M KCl electrolyte comes in contact with a less concentrated aqueous sample, diffusion of the electrolyte into the sample will occur. This process causes a progressive dilution of the reference electrolyte with a consequent variation of the reference potential.

Hanna double junction technology and the use of a large electrolyte volume (up to three times greater than traditional electrodes) makes this dilution effect negligible.

## Electrochemical Reaction

In many industrial applications, it is possible to get a potential difference between the measuring point and the instrument. This inconvenience originates from electrical currents that destroy the Ag/AgCl element of the reference half-cell and also creates non-stable, interfering potentials.

Hanna's simple and effective solution to this challenge is the matching pin built-in to each industrial electrode. The matching pin is a stainless steel or titanium element that is connected to the instrument to prevent grounding problems, and to prolong electrode life.

## Junction Clogging

Typical industrial applications require continuous monitoring of pH and ORP. Periodic cleaning and maintenance of the electrode junction ensure a stable and repeatable contact between sample and junction. The frequency of these cleaning procedures depends on the shape of the junction and material.

Hanna industrial electrodes are provided with different types of junctions. In particular, the porous PTFE junction used for the flat tip electrodes, which can provide optimum performance for months without requiring any maintenance.

## Measurement Half Cell

All Hanna industrial pH electrodes include a measurement cell with a glass sensor. A glass sensor is the only answer for most industrial requirements. Below is a list of the main causes of shortened glass sensor life, for which Hanna has developed different types of specialized glass:

- High temperature
- Low temperature
- Acid samples containing fluoride



# Process Electrodes

## Built for Everyday, Demanding Use

Hanna provides glass sensors that are able to withstand the previously listed industrial environmental challenges.

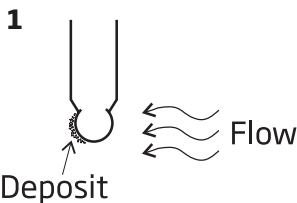
Glass Type	Application	pH Range	Temperature Range
LT	low temperature	0 to 12	-10 to 80°C
HT	high temperature	0 to 14	0 to 100°C
HF	acid samples with fluoride	0 to 10	-5 to 60°C

## Mechanical Stress

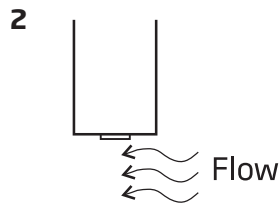
In a continuous in-line installation, the glass sensor of the pH electrode can be physically damaged by solution streams containing suspended solids.

Our Flat Tip electrodes are the best answer to this problem. The flat tip virtually eliminates deposits that can foul the electrode, significantly reducing necessary maintenance.

## Flat Tip Advantages



An exposed electrode surface will foul and require frequent cleaning



The flat shape of the electrode tip nearly eliminates deposits

## Electrode Body Material: Glass, PVDF or PEI



### Glass

The glass body electrode can withstand high pressure and high temperature applications. The glass body also offers high resistance to aggressive chemicals (only fluoridic acid and strong alkaline solutions can damage glass).



### PVDF

The PVDF body used for the Flat Tip Series withstands high pressure and high temperature applications, and guarantees a high chemical and mechanical resistance. These characteristics makes the PVDF material the most recommended for many industrial applications. PVDF is also non-toxic and compatible with food applications.



### PEI

PEI is a special plastic material used first to produce electrodes by Hanna. PEI electrodes proved to be ideally suited to field applications, as well as industrial environments. An electrode with a PEI body represents a very good combination of chemical, mechanical, and thermal resistance which can be used in non-critical applications (e.g. swimming pools), or with portable meters for routine field monitoring and control, such as wells, lakes and rivers, and discharges of tanks and reservoirs.



### Cable Leakage

A high impedance coaxial cable, when installed more than 5 meters away from the electrode, could also be subject to current leakage. Quite often the installers place it in underground ducts as done with any other electric cable. During the installation of the cable, the insulation may become scratched by rubbing against the pipes or sharp corners. Underneath the insulation there is a screen connected to the reference electrode.

If the cable is in an underwater duct, it could happen that, sometime during the year, the reference electrode (the screen) could come into contact with the humid environment and, thus, with the grounding circuit of the electrical installations. Under these conditions, the pH electrode cannot take reliable measurements and can give erroneous readings. Without any reference to the measurement, the actual reading can be many pH units off. This is another solid reason for avoiding cables longer than 5 meters.



### AmpHel: Why and Where to Use It

pH electrode glass sensors have a high impedance of typically 100 Mohm, but can reach 800 Mohm depending on the temperature. This is a very weak signal available for accurate measurements. Impedance this high is difficult to handle especially between the electrode and the instrument. Normally this distance is covered by special cables with very high shielding and electrical insulation. Even with these cables, distances cannot be longer than 5 meters.

In industrial installations it is not easy to limit the distance between the electrode and the measuring instrument to 5 meters. Quite often, the recording instruments are located in separate areas from where the pH is measured. To avoid this limitation, a pH amplifier can be used.

Amplifiers are usually available with water-tight casings and can be used under extremely harsh conditions. The pH amplifier needs a power supply and usually must also provide for galvanic insulation between the power supply and the amplification circuit. At times it is difficult to have a power supply close to the measuring electrode. In such a case, 2-wire amplifiers and a 4-20 mA output can solve the problem (see HI8614 and HI8614L produced by Hanna).

Such amplifiers need instruments with 4-20 mA input in place of, or in parallel with, the BNC connector (some instruments are not provided with this option).

To overcome the instrument limitation, in 1988, Hanna produced the AmpHel electrode (Amplified pH electrode). The AmpHel electrodes feature an internal, high impedance pH amplifier with the required batteries.

An AmpHel electrode has a life of approximately 3 years from the day it was produced. Taking into consideration that an average life for a pH electrode is one year, this should not be considered a limitation.

The output is still with 2 wires, as in the case of the typical coaxial cable, but it has a low impedance, and allows connections up to 75 meters long without delays in the measurements.

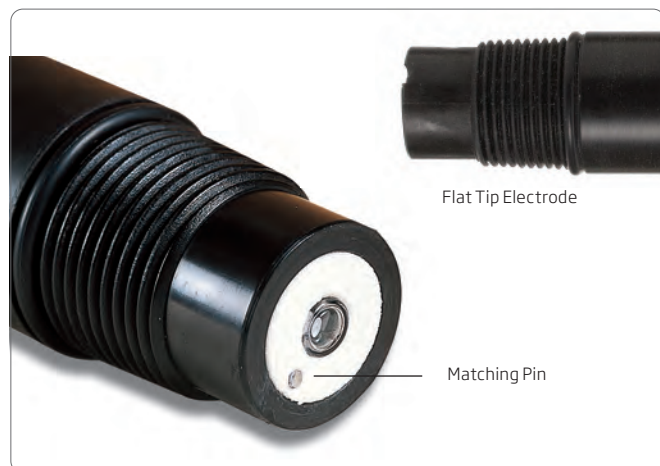
### Electrode-Cable Connection

Some German manufacturers have produced pH electrodes with a coaxial connector mounted directly at one end of the electrode, i.e. without cable. The intention was to replace the electrode, without having to replace the connecting cable which remains attached. But as time passed, such an intention has proven to be harmful.

In fact, in many cases, the electrode is placed inside an electrode holder, which protects it from test liquid (tank measurement). Moisture forms inside the holder because of temperature changes from day to night. This moisture reduces the connector insulation, and the signal to the electrode drops.

When an electrode leaks, the generated emf drops and the reading drifts toward the pH 7 value. Therefore, for example, instead of pH 3, the measurement can be pH 3.5 or 4. This reading may result in a dosage that is harmful to the system.

# Process Electrodes



## Potential Matching Pin

In many industrial applications, especially in plating baths, grounding loop current is a very common problem.

When a traditional electrode/controller system is used with the electrode reference connected both to the electrode and to the instrument, a current flow occurs through the reference half cell, causing fluctuations in reading and serious damage to the Ag/AgCl element. The potential matching pin shields the reference from external electrical fields. Shown above, the matching pin allows the measurement to stabilize and ensures effective process regulation. In order to function properly, the matching pin has to be continuously immersed in the measured solution and for this reason is placed near the electrode junction.

## Temperature Effect

Sample temperature is an important parameter for solutions with a pH different from 7.0. In fact at pH 7.0, temperature compensation is not required.

Due to a built-in temperature sensor, there is only one electrode to install. Also due to its proximity to the pH sensor, the built-in temperature sensor ensures fast, accurately compensated readings even during sudden temperature fluctuations.

## A Specific Electrode for Each Application

The table to the right lists the most common industrial applications with the corresponding, recommended Hanna electrodes.

For each application, several models are available, with different options for the following characteristics:

- Electrode dimensions
- Connection type
- Installation requirement
- Optional configurations (matching pin, Pt100 or Pt1000 sensor)

Hanna produces a wide range of industrial electrodes, for any specific application need.

## Common Industrial Applications

Application	pH Electrode Series Code	
Domestic Wastewater Sewage, Septic Tank Treatment	easy	HI1090B/5
Industrial Wastewater	flat tip	HI1006-2005
	HI1000	HI1003/5
	easy	HI1210B/5
Food Industry (Beer, Jam, Dairy Products)	flat tip	HI1006-2005
	easy	HI1090B/5
Chemical Neutralization	flat tip	HI1006-2005
	easy	HI1210B/5
Potable Water ( $>400\mu\text{S}/\text{cm}$ )	flat tip	HI1006-2005
	HI1000	HI1001
	easy	HI1210B/5
Cooling Towers	AmpHel	HI6291005
	HI1000	HI1002/5
	easy	HI1210B/5
Water Softening	flat tip	HI1006-2005
	AmpHel	HI6291005
	HI1000	HI1001/5, HI1002/5
Demineralization	easy	HI1210B/5
	flat tip	HI1006-2005
Low Conductivity Solutions	easy	HI1090B/5
	flat tip	HI1006-2005
Swimming Pools	flat tip	HI1006-2005
Sea Water	easy	HI1090B/5
Galvanic Baths	flat tip	HI1006-3005
	AmpHel	HI8299505
	HI1000	HI1003/5
Sugar Industry, Paper Industry	easy	HI1210B/5
	flat tip	HI1006-2005
Textile Industry, Tanneries	easy	HI1090B/5
	flat tip	HI1006-3005
Acid Samples with Fluoride Ions	AmpHel	HI8299505
	flat tip	HI1006-4005

Application	ORP Electrode Series	CODE
Oxidation of Cyanide and Nitrite	flat tip	HI2004-2005
Ozonization & Oxidant Products	AmpHel	HI6493005
Reductant Products (Chromate Reduction)	AmpHel	HI6293005
	HI2000	HI2003/5
	easy	HI3210B/5
Swimming Pools	HI2000	HI2001, HI2003/5
	easy	HI3210B/5

# Flat Tip Industrial Electrodes

Select the flat tip electrode that best fits your process requirements by choosing from the following technical characteristics:

## 1. Junction

Three junction types are available:

- Annular non-clogging PTFE junction, for testing solutions with high content of suspended solids or for high pressure installation
- Open junction, ideal for wastewater analysis
- Ceramic junction

## 2a. pH Electrodes

Hanna has developed four types of specialized glass. First is a durable sensor glass for general purpose, industrial use. This glass can withstand the stress of daily use. The remaining types of electrode glass allow continuous monitoring in highly acidic solutions containing fluoride ions, as well as high or low temperature process and streams significantly increase the electrode life.

## 2b. ORP Electrodes

ORP electrodes are provided with a platinum sensor for most applications, while a gold sensor is required for measurement of cyanide or highly oxidative environments.

## 3. Temperature Sensor

The pH electrodes with built-in 3-wire Pt100 or Pt1000 temperature sensor allow for the temperature compensation of pH readings as well as temperature measurements.

## 4. Connection Type

Electrodes are wired for direct connection to a transmitter or process controller, or with the standard BNC connector.

## 5. Built-in Amplifier

Models with a built-in amplifier are necessary for long distance measurements, where it is not possible to install a transmitter.

The internal amplifier can be powered directly from select Hanna process controllers or a power source that supplies the appropriate voltage.

## 6. Cable Length

Non-amplified electrodes are provided with a 5, 10 or 15 m cable (16', 33' or 49'), while the amplified models are provided with a 15, 25, 50 or 75 m cable (49, 82, 164 or 246').



- Self-cleaning flat tip sensor
- Significantly reduced maintenance requirement
- Models especially designed for plating baths
- PVDF body
- Three junction types: ceramic, PTFE and open
- Built-in potential matching pin
- Three different glass type pH sensors
- ORP electrodes with platinum or gold sensor
- Models with built-in Pt100 or Pt1000 temp. sensor
- Internal amplifier models powered by the process controller
- 3/4" NPT external thread on both ends for easy installation

Hanna presents a series of combination pH and ORP electrodes, including more than 300 models, incorporating over 20 years of electrode manufacturing experience.

The most advanced feature of this series is the electrode shape with a flat tip, virtually eliminating deposits that can foul the electrode, significantly reducing necessary maintenance. This characteristic makes flat tip electrodes ideal for continuous in-line monitoring and for solutions containing aggressive chemicals.

The PVDF body offers a higher level of mechanical and temperature resistance. Moreover, the PVDF material is non-toxic and compatible with food applications.

Each pH and ORP electrode is provided with an internal matching pin that can avoid typical problems caused by grounding loop current, such as:

- progressive damage of the electrode
- fluctuating measurements
- poor process regulation

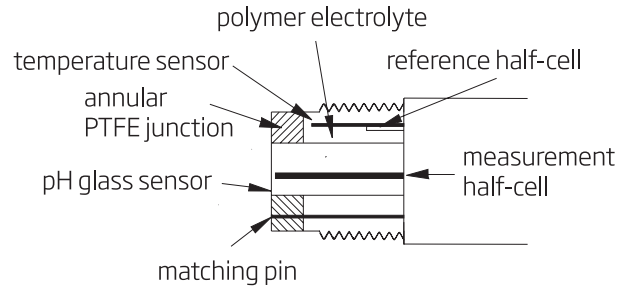
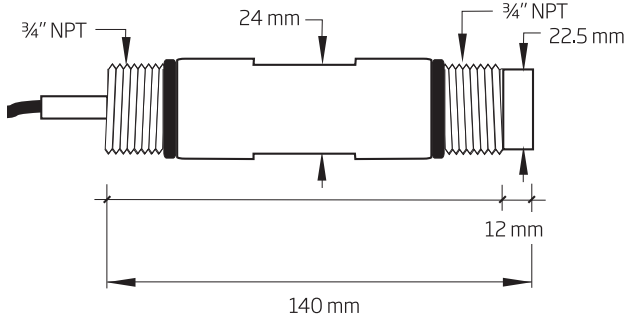
Glass Type	Application	pH Range	Temperature Range
LT	low temperature	0 to 12	-10 to 80°C
HT	high temperature	0 to 14	0 to 100°C
HF	acid samples with F <sup>-</sup> (*)	0 to 10	-5 to 60°C

(\*) F<sup>-</sup> - max 2 g/L, temperature max 60°C, pH > 2

# 15 Flat Tip Industrial pH Electrodes

Process Instrumentation

electrodes



### Flat Tip pH Electrodes: Ordering Information

Choose your configuration:

w =	06	PTFE junction
	16	ceramic junction
	26	open junction*
x =	1	LT (Low Temperature) glass sensor
	2	GP (General Purpose) glass sensor
	3	HT (High Temperature) glass sensor; titanium matching pin
	4	HF (Fluoride resistant) glass sensor
y =	0	BNC connector
	1	direct wire connection
	2	BNC connector + Pt100
	3	direct wire connection + Pt100
	4	BNC connector + Pt1000
	5	direct wire connection + Pt1000
	6	amplified electrode with BNC connector
z =	05, 10, 15	Cable length (meters); for non-amplified electrodes
	15, 25, 50, 75	Cable length (meters); for amplified electrodes

**HI10** w - x y z

\* Open junction is available only with GP glass sensor.

Note: The internal amplifier can be powered directly from select Hanna process controllers or a power source that supplies the appropriate voltage.