Process Electrodes and Probes

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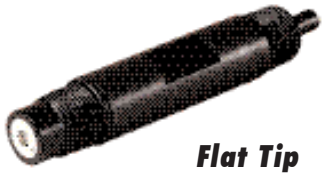
Since the beginning of the 1990's HANNA instruments® has been a leader in the research & development of pH and ORP electrodes. Today, HANNA instruments® is proud to present the latest family of industrial electrodes, the Flat Tip series, which completes the wide range of HANNA instruments® probes for any process application. All HANNA instruments®' 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.

AmpHel®



Flat Tip

Industrial Electrodes and Probes

Easy

HI 1000 / HI 2000 Series

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

HANNA instruments® has found the solutions for all these challenges, thanks to several years of experience and electrode testing in industrial applications.

Electrolyte Contamination

The contamination of the reference half-cell is linked to the diffusion of external substances into the reference chamber (strong oxidants, reductancts, complexing agents).
The combination of HANNA instruments®' 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 a reference cell, containing a very concentrated solution, comes in contact with a water solution sample much less concentrated, a diffusion phenomenon will take place on the electrolyte/sample junction, i.e. the diffusion of the electrolyte (KCl) into the sample solution. This process causes a progressive dilution of the reference electrolyte with a consequent variation of the reference potential.
HANNA instruments®' double junction technology and the use of a large electrolyte volume (up to three times greater than traditional electrodes) makes the 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 currents able to destroy the Ag/AgCl element of the reference half-cell and creates non-stable, interfering potentials.
The simple and effective HANNA instruments® solution to this challenge is the matching pin built-in to each industrial electrode, a unique characteristic in the market. The matching pin (see also page T2.6) is a stainless steel or titanium element that is connected to the instrument to prevent grounding problems, and thus 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 junction shape and material.
HANNA instruments®' industrial electrodes are provided with different types of junctions. In particular, we want to highlight the porous Teflon® junction used for our Flat Tip electrodes, which, thanks to its shape, can provide optimum performance for months without requiring any maintenance.

Measurement Half-Cell

All HANNA instruments® industrial pH electrodes include a measurement cell with glass sensor.
Even though it can be difficult to handle, the glass sensor is still the only answer for most industrial requirements. Below is a list of the main causes of shortened glass sensor life, for which HANNA instruments® has developed different types of specialized glass:
- High temperature
- Low temperature
- Acid samples containing fluoride

HANNA instruments® provides glass sensors that are able to withstand the previously listed industrial environmental challenges.

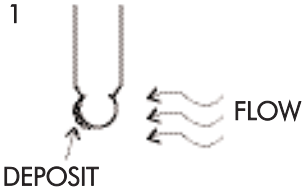
Glass Type	Application	pH Range	Temperature Range
LT	Low Temperature	0 to 12	-10 to 80°C
HT	High Temperature	0 to 14	0 to 100°C
HF	Acid Samples with Fluoride	0 to 10	-5 to 60°C

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.

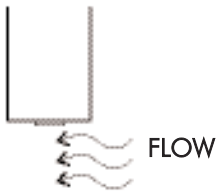
Flat Tip Advantages

1



Exposed electrode surface will foul and require frequent cleaning.

2



The flat shape of the electrode tip nearly eliminates deposits.

Electrode Body Material: Glass, PVDF or Ultem®

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.

Ultem®

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

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, the distance cannot be longer than 5 meters.

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

Amplifiers are usually available with water-tight casings and can be used under the worst 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 two-wire amplifiers and a 4-20 mA output can solve the problem (see HI 8614 and HI 8614L produced by HANNA instruments®).

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, HANNA instruments®, in 1988, produced the electrode AmpHel® (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. Considering an average life for a pH electrode of one year, 3 years from the date of production 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.

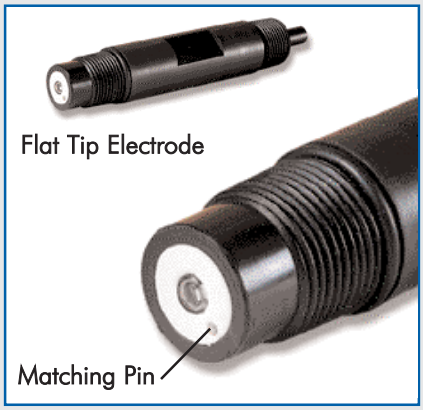
Cable Leakage

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, as in a rainy season, the reference electrode (the screen) comes into contact with the humid environment and, thus, with the grounding circuit of the electrical installations. Under these conditions, the pH electrode cannot take measurements and will give erroneous readings of up to many pH units without any reference to the measurement. This is an additional good reason for avoiding cables longer than 5 meters.

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. As time passed, such a solution has proven to be dangerous.
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.



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 at right, 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

The sample temperature is a very important parameter for solutions with a pH different from 7.0. In fact at pH 7.0, temperature compensation is not required.
Thanks to a built-in temperature sensor, the electrode is easy to install. Also due to its proximity to the pH sensor, our flat tip electrode's built-in temperature probe ensures fast, accurately compensated readings even during sudden temperature fluctuations.

A Specific Electrode for Each Application

The table on the next page lists the most common industrial applications with the corresponding, recommended HANNA instruments® electrodes.
For each application, several models are available, with different options for the following characteristics:
- electrode dimensions
- connection type
- installation requirement
- accessories (matching pin, Pt100 or Pt1000 sensor)

HANNA instruments® produces a wide range of industrial electrodes, for any specific application need.

Common Industrial Applications, pH Electrodes

Application	Electrode Series	Part Number
DOMESTIC WASTEWATER	FLAT TIP	HI 1026-2005
SEWAGE, SEPTIC TANK TREATMENT	EASY	HI 1090B/5
INDUSTRIAL WASTEWATER	FLAT TIP	HI 1006-2005
	AmpHel®	HI 5291005
	HI 1000	HI 1003/5
	EASY	HI 1210B/5
FOOD INDUSTRY	FLAT TIP	HI 1006-2005
(Beer, Jam, Diary Products)	AmpHel®	HI 5291005
	EASY	HI 1090B/5
CHEMICAL NEUTRALIZATION	FLAT TIP	HI 1006-2005
	AmpHel®	HI 5291005
	EASY	HI 1210B/5
POTABLE WATER (>400µS/cm)	FLAT TIP	HI 1006-2005
	AmpHel®	HI 5291005
	HI 1000	HI 1001
	EASY	HI 1210B/5
COOLING TOWERS	FLAT TIP	HI 1006-1005
	AmpHel®	HI 6291005
	HI 1000	HI 1002/5
	EASY	HI 1210B/5
WATER SOFTENING	FLAT TIP	HI 1006-2005
	AmpHel®	HI 6291005
	HI 1000	HI 1001/5, HI 1002/5
	EASY	HI 1210B/5
DEMINERALIZATION	FLAT TIP	HI 1006-2005
	AmpHel®	HI 5291005
	EASY	HI 1090B/5
LOW CONDUCTIVITY	FLAT TIP	HI 1006-2005
SOLUTIONS	AmpHel®	HI 5291005
SWIMMING POOLS	FLAT TIP	HI 1006-2005
	AmpHel®	HI 5291005
SEA WATER	FLAT TIP	HI 1026-2005
	AmpHel®	HI 5291005
	EASY	HI 1090B/5
GALVANIC BATHS	FLAT TIP	HI 1006-3005
	AmpHel®	HI 8299505
	HI 1000	HI 1003/5
	EASY	HI 1210B/5
SUGAR INDUSTRY, PAPER INDUSTRY	FLAT TIP	HI 1006-2005
	AmpHel®	HI 5291005
	EASY	HI 1090B/5
TEXTILE INDUSTRY, TANNERIES	FLAT TIP	HI 1006-3005
	AmpHel®	HI 8299505
ACID SAMPLES WITH FLUORIDE IONS	FLAT TIP	HI 1006-4005
	AmpHel®	HI 7291005, HI 7299505

Common Industrial Applications, ORP Electrodes

Application	Electrode Series	Part Number
OXIDATION OF CYANIDE & NITRITE,	FLAT TIP	HI 2004-2005
OZONIZATION & OXIDANT PRODUCTS	AmpHel®	HI 6493005
	HI 2000	HI 2013/5
REDUCTANT PRODUCTS	FLAT TIP	HI 2004-1005
(Chromate Reduction)	AmpHel®	HI 6293005
	HI 2000	HI 2003/5
	EASY	HI 3210B/5
SWIMMING POOLS	HI 2000	HI 2001, HI 2003/5
	EASY	HI 3210B/5