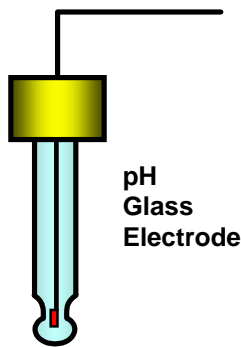


Technical Feature  
Eutech Instruments  
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## Differential pH measurements

Measurement of pH in wastewater has always posed several challenges. Of the many problems one might face under such circumstances, the most common would probably be fouling of the reference electrode system.

A conventional combination pH electrode is made up of two parts. The first is the glass electrode and the second, the reference. The glass electrode is made of a special glass bulb attached to one end of a glass stem. This is usually done by a glass blowing process. This bulb is a pH sensitive membrane. The inside of the bulb is filled with a conductive buffered solution. A silver wire is immersed in this solution. This configuration is usually referred to as the glass or measuring electrode. Refer to figure below (Diagram 1):



pH  
Glass  
Electrode

Diagram 1

It can be seen that the only part of the glass electrode system that comes into contact with the sample is the glass bulb itself. The inner fill solution and the silver wire are physically isolated from the sample. Therefore very rarely does one see any problems associated with these components. The problems to look for however would be related to exposure of the bulb to harsh chemicals like hydrofluoric acid that may attack glass.

The reference electrode is much simpler in construction. In its simplest form, it consists of a reference chamber, a reference junction and silver wire. The reference junction is usually made of porous material. Its function is to allow the reference electrolyte to flow from the chamber through to the sample and thus establish an electrical connection. Refer to figure below (Diagram 2):

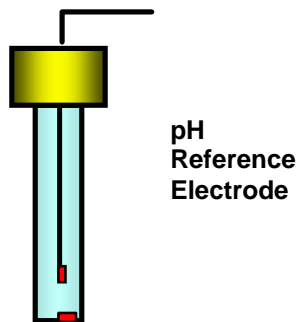


Diagram 2

It can be seen from the diagram above that unlike the glass electrode, the reference is prone to contamination or fouling from outside. The problems generally seen are reference junction blocks, contaminants entering the reference chamber and thus reacting with the reference electrolyte and / or the silver wire. In wastewater measurements this could happen easily due to pressure heads. In either case, the performance of the pH electrode as a whole would be compromised.

In cases where a reference contamination is likely, one option that may be available is to use a double junction electrode. In this type of electrode, a second junction is introduced between the first junction and the reference silver wire. This serves to delay the contamination process but does not eliminate it completely.

We notice that the glass electrode system is less prone to such problems. With this in mind, can we not think of a reference electrode system built very similar to that of the glass electrode? The answer is the differential pH electrode.

The difference in construction between a simple combination pH electrode and a differential pH electrode can be easily understood from figure shown below (Diagram 3):

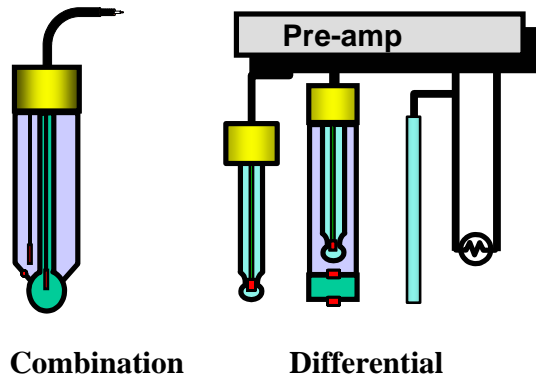


Diagram 3

The reference part of the differential electrode is very similar in construction to that of the glass electrode. The reference chamber can be filled with a conducting salt solution. This electrolyte can be emptied and refilled if necessary.

In order to make the electrode more superior, the reference junction can be replaceable type. The advantage would be that in the event the junction clogs; it could be easily replaced thus extending the life of the electrode.

Problems associated with ground loops potentials can be eliminated by having a liquid ground built into the electrode. The pH and reference voltages will be measured by the instrument with respect to the ground pin potential and therefore be free from the effects of the ground loop potential as shown in the simple electrical model of the differential electrode in the figure below (Diagram 4):

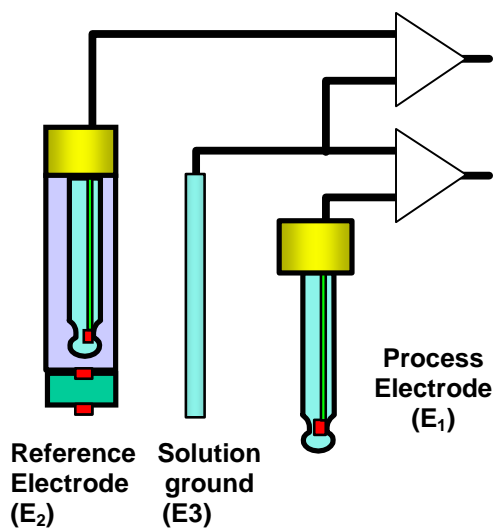


Diagram 4

The final signal of interest would be  
 $(E1 - E3) - (E2 - E3)$  which is  $E1 - E2$

Advantages of the differential pH electrode can be summarized as follows:

- Longer sensor life in a wide range of measurement environments.
- The reference electrode solution is buffered and less susceptible to contamination than the standard KCL reference solutions used in combination electrode systems.
- Any buffer standard from 2 pH to 10 pH can be used as a reference. This is very useful for applications that require adjustable isopotential points.
- The reference electrode is a pH glass bulb and the inner fill and silver wire are not easily contaminated. For standard combination electrode systems silver/silver chloride wires are used as a reference and can react with some process chemicals over time.
- Reference solutions and salt bridges can be easily replaced when fouling does occur.
- Integral electronic amplifiers measure potential difference of the process electrode and the reference electrode with respect to solution ground. This provides a low impedance output from the sensor which results in the following benefits:
  - Extended cable lengths of up to several hundred feet
  - Low noise and expensive coaxial cable is not needed.
  - Hand capacitance is dramatically reduced – readings do not fluctuate when sensors are held.
  - Electrical interference from motors, pumps and transformers are reduced.
  - Ground currents are essentially eliminated.

It is therefore evident that the differential pH electrodes can last much longer than the conventional electrodes even in a harsh wastewater environment.

Differential pH electrodes need special input electronics and cannot be connected to conventional pH transmitters and controllers. A good example of a differential pH system is the Alpha pH 2000D Controller (Diagram 7) and the Differential pH Electrode (Diagram 5) from Eutech Instruments.

Diagram 5: Eutech Differential pH Electrode

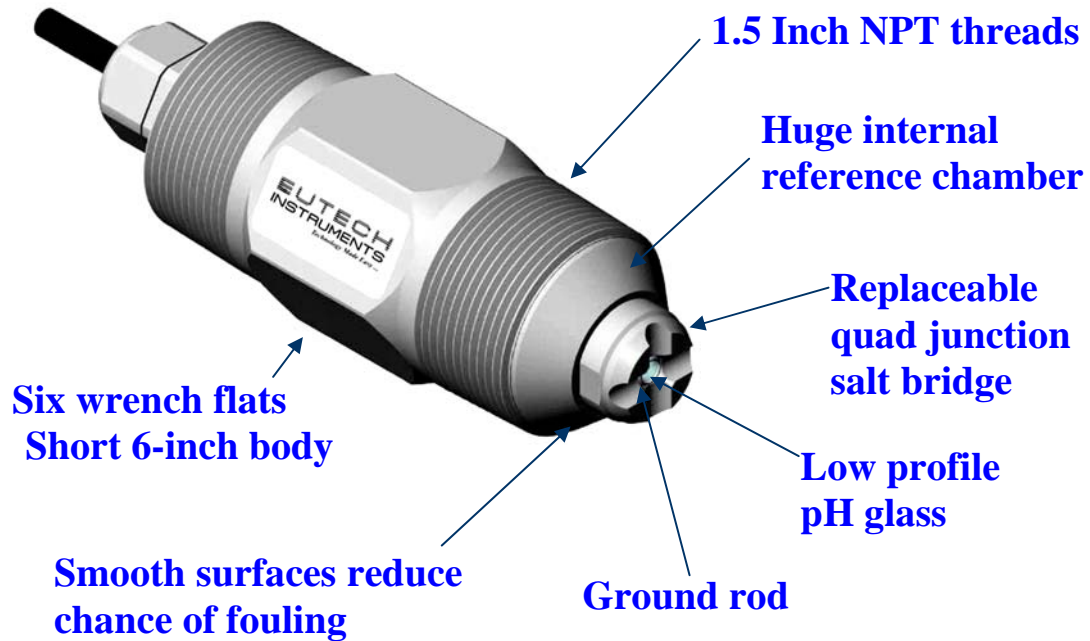


Diagram 6: Cross-section of the Eutech Differential pH Electrode

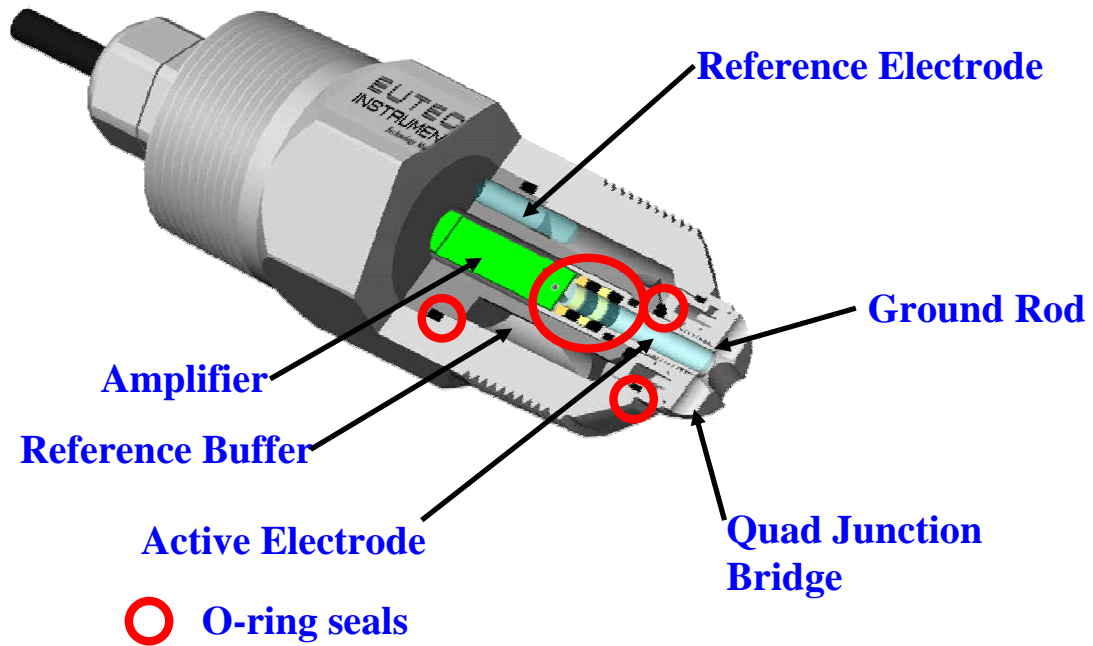


Diagram 7: Alpha pH2000D Controller



Article is submitted by Mr. Bhaskar Narayanan (Managing Director) and Mr. Subramanian Raghuraman (General Manager - Technical) of Eutech Instruments, a leading ISO9001 certified water quality analysis instrumentation manufacturer that markets their comprehensive product ranges worldwide through an extensive distributor network. For more information, please contact our distributors or visit our corporate website at [www.eutechinst.com](http://www.eutechinst.com)