Application Article

Understanding Differential pH measurements

The solution for wastewater measurement

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.

The limitations of a conventional combination electrode

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):

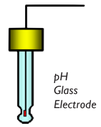


Diagram 1

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 one rarely sees any problems associated with these components. Potential problems however, would be related to exposure of the bulb to harsh chemicals like hydrofluoric acid that may attack the glass.

"The conventional reference electrode is prone to contamination"

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):

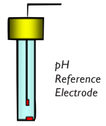


Diagram 2

Unlike the glass electrode, the reference electrode is prone to contamination or fouling from outside. The problems generally seen are reference junction blocks and 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 any 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.

The benefits of a differential electrode

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):

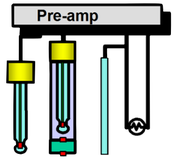


Diagram 3

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.

"The reference electrode is a pH glass bulb and the inner fill and silver wire are not easily contaminated"

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

Problems associated with ground loops potential 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):

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

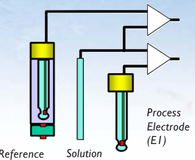


Diagram 4

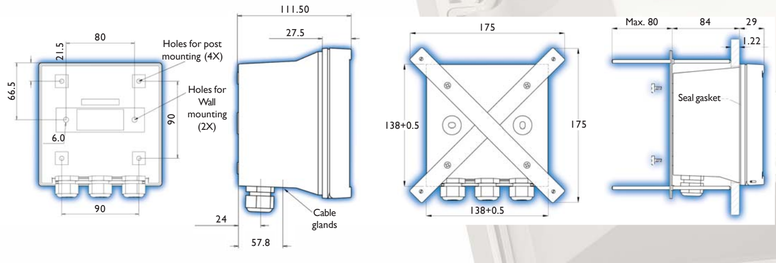
Advantages of the differential pH electrode can be summarized as follows:

- 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 (Potassium Chloride) reference solutions used in combination electrode systems.
- Any buffer standard from 2 to 10 pH can be used as a reference. This is very useful for applications that require adjustable isopotential points.
- 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 occurs.
- 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 so that 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.

Featured in Asian Environmental Technology (March 2005), Asian Water (November 2005) and Water and Wastewater Asia (November 2004).

Wall Mount Drawings (All measurements in mm): *For illustration only.*



Warranty

Eutech Instruments warrants its controller to be free from manufacturing defects for twelve months and electrodes for six months.

Note: Eutech Instruments reserves the rights to make changes, improvements and modifications to products shown without prior notice.

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αlpha pH 2000D

DIFFERENTIAL pH/ORP PROCESS CONTROL SYSTEM

Cutting edge measurements in harsh environments

EUTECH INSTRUMENTS
Technology Made Easy ...

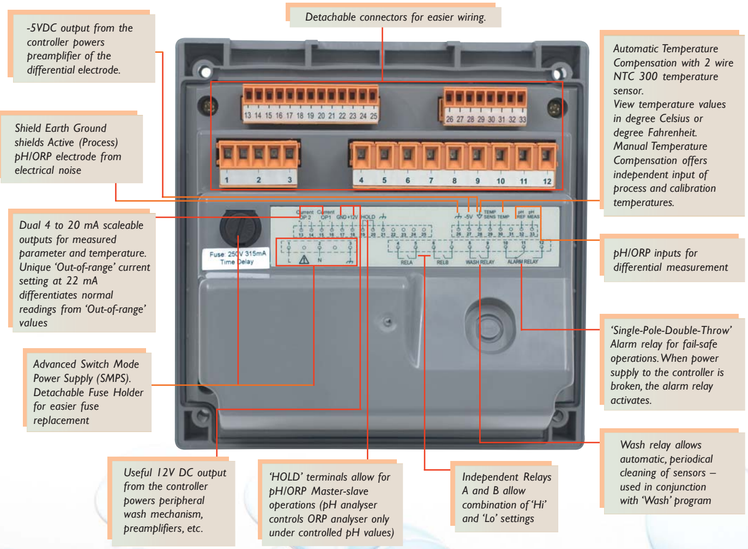
The αlpha Differential pH / ORP Process Control System

Eutech Instruments' Differential pH/ORP Measurement Technology consists of the αlpha pH 2000D controller and a pH/ORP differential electrode. Unlike conventional combination electrodes, the differential electrode is designed for more durability in harsh industrial environments such as wastewater treatment. The unique electrode design prevents fouling of the reference electrode system. The salt bridge and reference solution is replaceable hence providing greater reliability, better accuracy and a more cost effective measurement system.

αlpha pH 2000D controller

The αlpha pH 2000D controller is custom designed for the differential pH and ORP electrodes - ECFP21A1A1 or ECFR21A1A1. Other features includes:

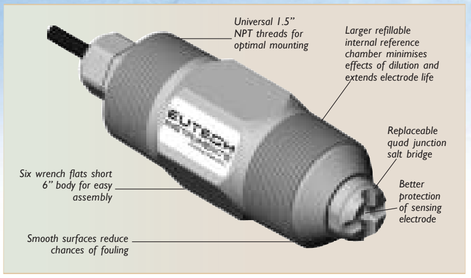
- Proportional / Integral / Differential Controller / Transmitter
- pH or ORP Mode in mV or %
- Menu-driven SETUP program
- Out-of-range current output of 22 mA
- Back-lit LCD display
- Ingress Protection of IP65 (NEMA 4X)



αlpha pH 2000D Specifications	
pH Range	-2.00 to 16.00 pH
Accuracy	±0.01 pH
Resolution	0.01 pH
mV range / Percentage mV Range	-1000 to 1000 mV / 0 to 100% (for -100 to 100 mV)
Accuracy	1 mV / 0.1%
Resolution	±1 mV / ±0.2% (or ±1 mV)
Temperature	-10.0 to 110 °C (14.0 to 230.0 °F)
Resolution	0.1 °C / °F
Relative Accuracy	±0.5 °C (±1.0 °F)
Temperature Sensor	NTC 300; 2 wire
Temperature Compensation	Auto / Manual (Independent Process / CAL Temperature)
Set Point and Controller Functions	
Set Point 1 (SP1) / Set Point 2 (SP2)	-2.00 to 16.00 pH or 0 to 100% or -1000 to 1000 mV
Hysteresis	0.1 to 1 pH or 1 to 10.0% / 10 to 100 mV
Function (Switchable)	P/PI control (Pulse Length / Pulse Frequency); Limit Control; Off
Proportional Range	10 to 500%
Integral Action Time (IAT)	0 to 999.9 minutes
Adjustable Period with Pulse Length Controller	0.5 to 20 seconds
Adjustable Period with Pulse Frequency Controller	60 to 120 pulses/min
Pickup / Dropout Delay	0 to 2000 seconds
Wash Cycle	0.1 to 200.0 hours
Wash Duration	1 to 2000 seconds
Switching pH Hysteresis	0 to 10% of full scale
Contact Outputs, Controller	1 SPDT, 3 SPST relays
Switching Voltage / Current / Power	Max 250 VAC / Max 3A / Max 600VA
Alarm Functions	
Function (Switchable)	Steady or Fleet (Pulse)
Pickup Delay	0 to 2000 seconds
Switching Voltage / Current / Power	Max 250 VAC / Max 3A / Max 600VA
Display	
LCD	UV coat, backlit 14 segments display with symbols for status information
Backlight	On/Off selectable with four levels of brightness control
Electromagnetic Compliance (EMC) Specifications	
Emitted Interference	According to EN 61326
Immunity to Interference	According to EN 61326
Environmental Conditions	
Ambient Temperature Operating Range	0 to 40 °C
Maximum Relative Humidity	80% up to 31 °C decreasing linearly to 50% at 40 °C
Power Supply	
Input	80 to 250 VAC/DC 50/60 Hz Approx. 10 VA
Main Fuse	315 mA time delay, 250 V, Bussmann BK/GDC-315 mA
Pollution Degree	2
Transient Overvoltage Category	II
Electrical Data and Connections	
Transmitter Function	Two 0/4 to 20 mA scalable outputs for pH/ORP and temperature, galvanically isolated
CU 22 Function	22 mA current output
Isolated Output Voltage	+12V ±0.5 V (Max 50 mA)
Hold Function Switch	To freeze output current and deactivate control relays
Load	Max 600 W
Differential pH/ORP Input	2 pin terminal
Connection Terminal	5-pin, 8-pin, 9-pin and 13-pin terminal, detachable blocks
Mechanical Specifications	
Dimensions (W x H x D)	144 x 144 x 110 mm
Weight	950g (unit) / 1100g (Packed)
Environmental Rating	IP65 (NEMA 4X)

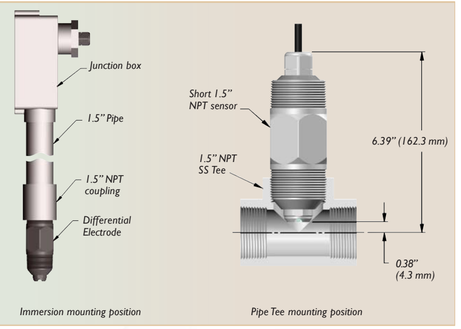
Order Information	
αlpha pH / ORP Differential Controller / Transmitter	ECPHCTP2000D

Differential pH and ORP electrodes

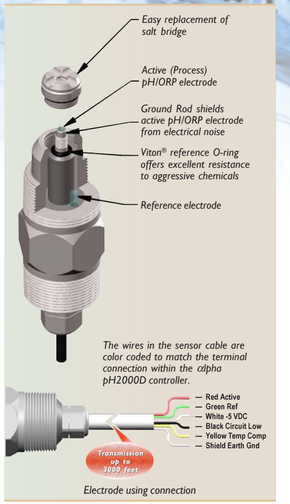


Benefits

- **Extended electrode life** - Larger reference chamber filled with buffer solution minimises the effects of dilution and prolongs electrode life.
- **Cost savings** - The soiled salt bridge and buffer reference solution can be easily replaced at a fraction of the cost of a new combination electrode.
- **Automatic Temperature Compensation** - Built-in temperature sensor.
- **Up to 3000 feet signal transmission** - Built-in preamp eliminates high impedance wiring problems hence signal transmission is possible up to 3000 feet and hand capacitance is prevented.
- **Minimised susceptibility to ground loops** - With differential pH/ORP measurement technology.
- **Optimal mounting positions** - Compact design ensures less obstruction when used in pipe mountings and universal 1.5" NPT mounting threads enables optimal mounting positions.



Order Information	
Differential pH Electrode (1.5" NPT Mounting Thread)	ECFP21A1A1
Differential ORP Electrode (1.5" NPT Mounting Thread)	ECFR21A1A1



Electrode Specifications	
Measuring Range	0 to 14 pH
Resolution	0.01 pH
Wetted Materials	Sensor Body - CPVC Salt Bridge - Kynar® Junctions pH Electrode - General glass Ground Rod - 316 Stainless Steel O-Ring Seals - Viton®
Operating Temperature	-5°C to 95°C (23°F to 203°F)
Maximum Pressure	100 psi @ 100°C / 212°F
Maximum Flow Rate	3 m/sec (10 ft/sec)
Standard Sensor Cable Length	3 m (10 ft)
Cable Wire Colors	White Wire (-5V) Black Wire (Ground) Red Wire (Active pH/ ORP Electrode) Green Wire (Ref Electrode) Yellow Wire (Temperature/ NTC 300) Drain/Shield (Shield Earth Ground)
Maximum Transmission Distance	914 m (3,000 ft)
Dimensions (L x W)	6.01" x 1.9" (152.7 x 48.3 mm)