BARBEN ANALYTICAL

Technical Note
Selecting Measurement Electrodes

Performance Series pH / ORP Sensors

There are many options to choose from when selecting the measurement electrode used in pH and ORP sensors. The purpose of this paper is help provide some further guidelines to aide in this process.

The Application
Selecting the measurement electrode begins with understanding the application variables.

- Expected measurement range (Min / Max / Average)?
- Process temperature (Min / Max / Average)?
- Process pressure (Constant or fluctuating)?
- Liquid composition (Chemistry of the stream)?
- Liquid characteristics (Abrasive / Viscous / Coating)?

The chart below shows the most common types of pH / ORP electrodes offered. Note that each design is influenced by the application they are to be used in.

An example of CR industrial high temperature glass pH electrode

Code	Glass Type	Suggested Applications	Recommended Measurement Range	Recommended Temperature Range	Maximum Temperature Range	Typical Impedance @ 25˚C (77˚F)
R CR	Industrial High Temp (Hemi) Industrial High Temp Coat Resist (Hemi)	Best choice for hi/low pH & high pressure. Coat resistant excels in NaOH. Hemispherical glass.	0 to 14 pH	15 to 100°C 59 to 212°F	15 to 130°C 59 to 266°F	375 MΩ
FG CF	Flat Industrial Glass Flat Industrial Glass Coat Resist	Best choice for in-line slurries. Consult if rapid pressure changes are present.	0 to 14 pH	20 to 85°C 68 to 185°F	20 to 130°C 68 to 266°F	600 MΩ
PX	Redox (ORP)	Flat Platinum (Pt) Billet. Non-glass. Easy to clean.	0 to ±1500mV	0 to 130°C 32 to 266°F	0 to 130°C 32 to 266°F	1 KΩ
E CE	General Purpose General Purpose Coating Resist	Light to medium duty pH electrode for low temperature applications. Not for high pH.	2 to 11 pH	-10 to 40°C 14 to 104°F	-20 to 50°C -4 to 122°F	25 MΩ
FA	Antimony (Sb) Non-glass Electrode	Antimony (metal) pH electrode for abrasives or HF acid or low temperature applications.	3 to 11 pH	-20 to 80°C -4 to 176°F	-20 to 80°C -4 to 176°F	1 KΩ
FR	Fluoride / HF Acid (Hemi)	Resistant to etching by HF and other strong acids. Hemispherical pH glass.	1 to 14 pH	15 to 100°C 59 to 212°F	15 to 130°C 59 to 266°F	375 MΩ
HR	Silica Resistant High Temp (Hemi)	Best choice for extreme pH where silica may coat traditional electrodes. Hemispherical glass.	1 to 14 pH	15 to 100°C 59 to 212°F	15 to 130°C 59 to 266°F	375 MΩ
FH	Silica Resistant Flat Glass	Best choice for slurries and heavy fouling where silica may coat traditional glass electrodes.	1 to 14 pH	15 to 85°C 59 to 185°F	15 to 130°C 59 to 266°F	600 MΩ

= Most common electrodes

= Special Application (Consult with factory)

R & CR pH Glass: Our most common industrial pH glass. The hemispherical tip provides high strength against pressure fluctuations. The large surface area of the glass gives the longest life in high temperature applications and best response at high or low pH. R glass is coating resistant. CR glass provides a secondary layer for difficult coating applications. Note - response will slow at lower process temperatures below 15°C.

FG & CF pH Glass: Flat glass pH electrodes excel in in-line applications where abrasive particles may be present. Flat glass tends to be more sensitive to pressure and temperature fluctuations. Operating pressures should not exceed 150 PSIG. Operating temperatures over 176˚F (80˚C) will shorten sensor lifespan. CF glass has a secondary coating resistant layer.

PX Redox (ORP) Electrode: The platinum BAT ORP electrode is a flat, flush design which allows for very easy cleaning. The platinum billet is mounted on a corrosion resistant PEEK stem. This design eliminates any glass thus reducing the chance of failure due to cracking.

E & CE pH Glass: Our general purpose glass is primarily used in low temperature applications. It is a good choice for water treatment measurements in open tanks and channels where the pH sensor will be outside. Please note that prolonged exposure to strong chemicals is not recommended. CE glass includes additional coating resistant layer for difficult applications.

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Special Application Electrodes

Some applications require specialty electrodes. Please consult Barben technical support when considering these products. Application variables will be needed (see page 1).

FA Antimony (non-glass) pH Electrode: Antimony metal produces a mV output in the presence of H^+ ions thus can be used for pH measurement. Measurements containing Hydrofluoric Acid are the most common applications. There are multiple considerations with antimony sensors:

- The pH analyzer must have an option to accept either an antimony or a specific ion sensor input (mV) signal.
- The output is linear from 3pH to 8pH. While the sensor will respond beyond this range the output Applications outside of this range should be avoided.
- Process temperature should be kept constant. Temperature changes can cause measurement errors up to ±3mV per °C. For this reason antimony sensors are not temperature compensated.
- Speed of response is often considerably slower then glass electrodes.

Temperature, pH, and HF acid concentration help to determine if an antimony electrode or conventional glass electrode is the best choice. In rare cases antimony has also be used in low temperature applications due to its low impedance.

FR Hydrofluoric Acid Resistant pH Glass: This pH glass formulation provides increased resistance to etching due to presence of HF or other strong acids. It may be suitable for applications where HF acid is 100 to 1000PPM (pH and temperature dependent). HF resistant pH glass is often a first choice over antimony electrodes due to issues highlighted above.

HR & FH Silica Resistant pH Glass: Silicates can bond to the pH sensitive glass thus reducing the sensor response. HR and FH glass use a special fluoropolymer coating to prevent silicate coating. Choose the HR glass unless abrasives are present.

GX Gold Redox (ORP) Electrode (Special Order): In certain applications such as strong reducers, gold is a better choice than platinum. Select gold ORP electrodes for zinc, cyanide, cadmium, and nickel extraction applications. The gold ORP electrode uses the same successful design as the platinum electrode. A flat billet electrode is used for easy cleaning and a PEEK stem for high durability.

Notes on Impedance and Temperature

Many pH analyzers offer some form of sensor diagnostics. A common diagnostic measurement is the impedance of the glass electrode. Typical impedance values for most electrodes are found on the preceding page. Changing impedance may indicate coating on the electrode or cracks in the glass. This measurement requires a solution ground built into the sensor. If no solution ground is available then impedance can be measured on the bench using a wire or metallic rod connected to the analyzer and placed in buffer solution with the sensor.

Impedance will vary from sensor to sensor due to manufacturing tolerances and sensor age. Impedance will also vary depending on temperature (increased impedance at lower temperatures). If the impedance is well below these published values than it is a good indication of a crack in the glass electrode (short circuit). Impedance can also be useful when cleaning the sensor. If a resistive coating such as oil is on the glass electrode the impedance will be higher than normal. The impedance will decrease as the coating is cleaned off the glass.

The chart on the following page lists recommended and maximum temperature ranges for each style of electrode. Installing the sensor within the recommended temperature range ensures the longest life. Typically higher temperatures will shorten sensor life due to increased ion activity. Lower temperatures will slow the response time of the sensor and may cause noisy outputs.

Contact Us

Barben Analytical is a leading supplier of analytical measurement technology targeting the industrial marketplace. It is a wholly owned subsidiary of Ametek.

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