Technical Note
Advanced Installation Techniques

Performance Series pH / ORP Sensors

pH sensor installation techniques can vary greatly from application to application. While our instruction manuals provide a great starting point to discuss proper installation they cannot always account for all the differences in process liquids, piping arrangements, and other factors that influence each pH sensor installation. With this in mind, the following technical note discusses some advanced installation techniques that should be considered when installing pH sensors. Topics include:

- Installation considerations in piping systems
- Installations in tanks and vessels
- Notched tip orientation with various glass electrode styles
- Sensor Insertion depth

Horizontal & Vertical Pipeline Installations

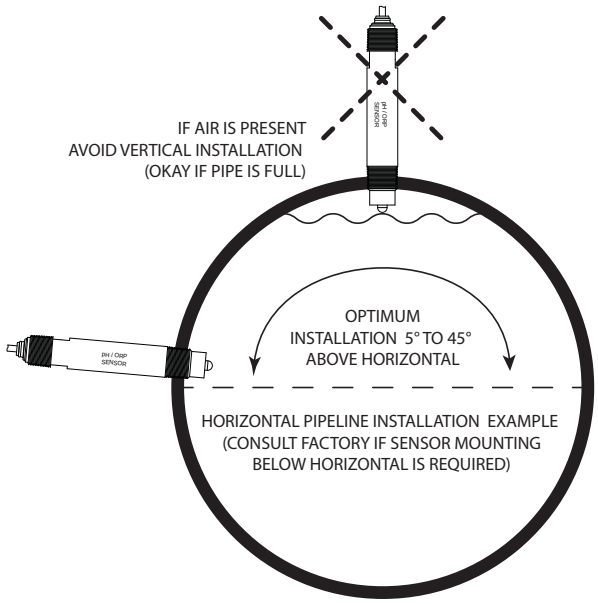
Figure 1 shows suggested installation points when mounting the pH sensor in horizontal or vertical pipelines. In all cases, the sensor is oriented above horizontal. The logic behind this recommendation is to account for the small air bubble inside the tip of the glass electrode. The purpose of the air bubble is to provide the sensor with a degree of expansion / contraction during rapid temperature changes. The air bubble is common to most glass pH electrode manufacturers. Without it, the glass electrode would be more susceptible to breakage.

During calibration, the sensor is placed tip-down in buffer solution and the air bubble floats up within the sensor body. With no air bubble present, the internal electrolyte is in full contact with the pH sensitive glass membrane. The slope calibration value is determined at this point.

It is desirable to have the sensor installed in the process with the same full contact between the electrolyte and the pH glass. In this manner, the slope response determined through calibration will provide the most accurate response to changing process pH.

Note that this air bubble can often be quite large. Barben Performance Series pH sensors have been designed with a very small air bubble to reduce the possibility of error due to air exposure on the surface area of the glass membrane. If the application requires the pH sensor to be mounted upside-down then a Performance Series sensor with a hemispherical glass electrode is the best choice.

Horizontal Pipeline Installation



Vertical Pipeline Installation

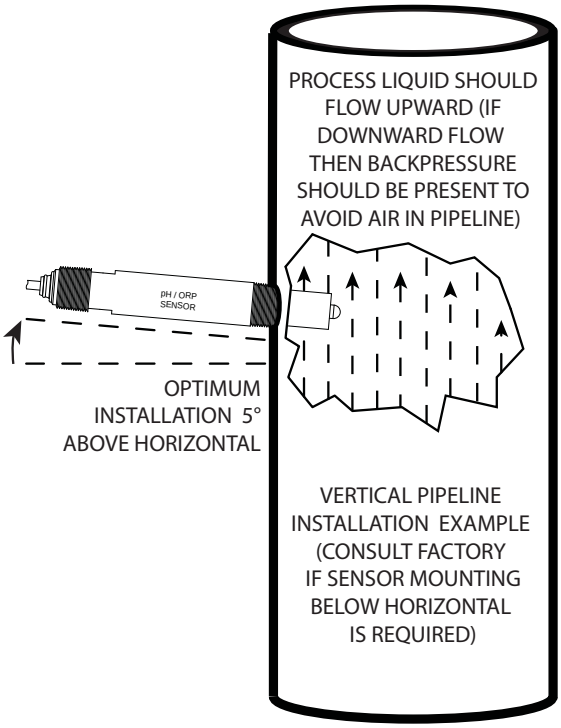


Figure 1

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Flow Considerations
pH measurement is not flow dependent *(ultrapure water is the exception)*; however, there are basic recommendations that can be used to help ensure longer sensor life.

Recommended flow velocity for typical pH sensor installations is between 3 to 8 ft/sec (1 to 2.5 m/sec). The flow velocity should be high enough that entrained solids stay in solution avoiding sedimentation and coating. Furthermore, excessively high flow velocity can cause particulate abrasion to the glass electrode or even physical damage (bending / breakage / vibration) to the sensor body.

The proximity to elbows and other flow restrictions will directly influence the flow velocity the sensor is exposed to. Figure 2 shows the distortion of the flow profile close to the elbow. The sensor will be functional but there is a higher probability for physical damage. A better measurement point is further downstream (at least 5 pipe diameters) where the flow profile is uniform across the pipe area.

Velocity and flow profile recommendations are not unique to only pH sensors. Pump, valve and flowmeter manufacturers often have similar requirements to ensure their products work properly when installed.

Tip Orientation & Depth
A notched tip on the sensor body plays a important role in protecting the glass electrode from breakage. When inserted into a flowing process, the notches affect the flow profile past the sensor. Orientation of the notched tip is an important consideration that is often overlooked. Figures 3 through 6 show different tip orientations along with their recommended applications. Both hemispherical and flat glass electrodes are also shown in these illustrations.

A Barben 547 retractable “hot tap” pH sensor is used in Figures 3 through six but the recommendations apply to any Barben pH sensor used in a flowing process.

Pipeline Installation Examples

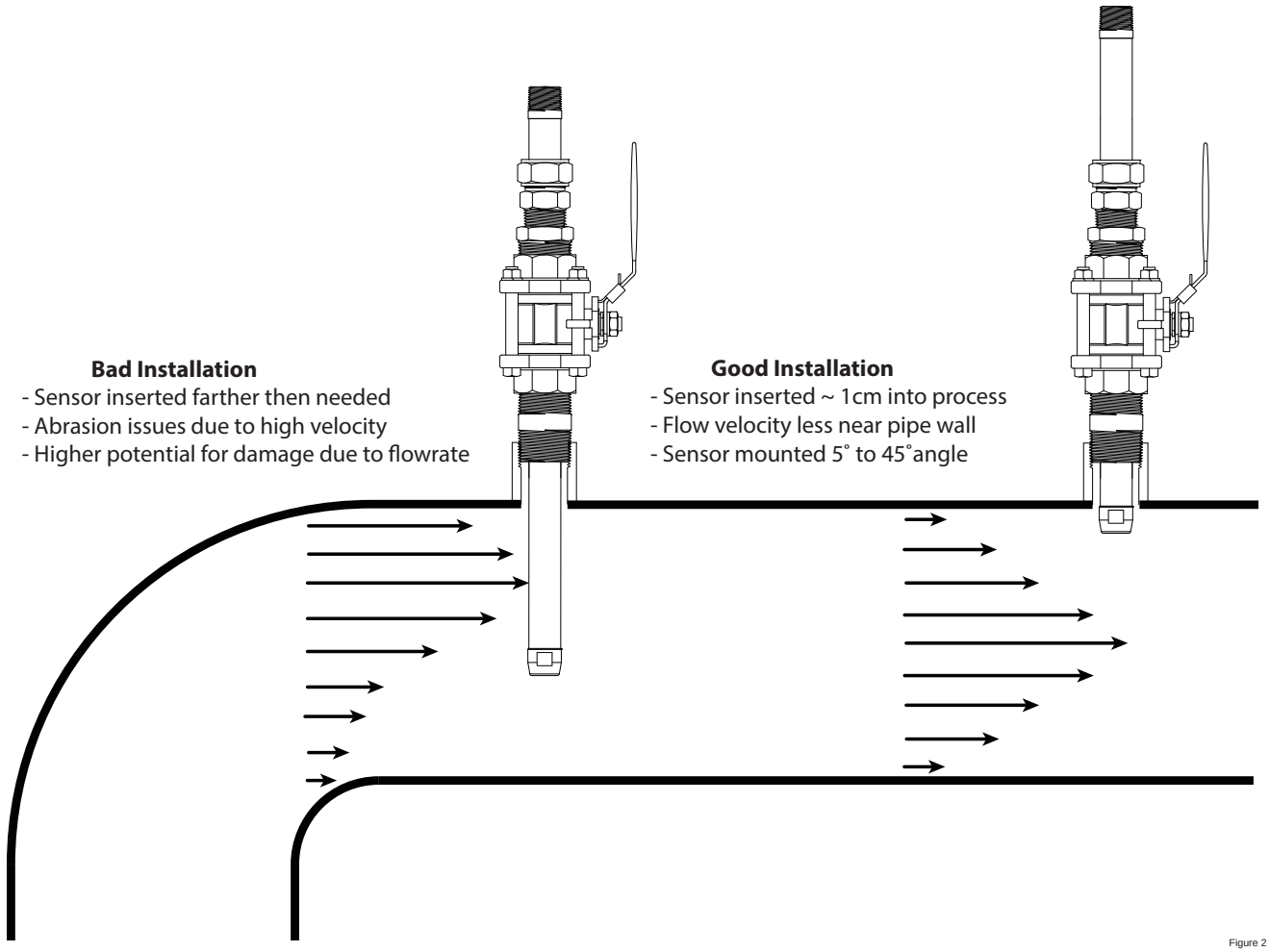


Figure 2

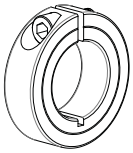
Hemispherical Glass Electrode Orientation Exposed to Flow

This orientation of the sensor tip is best suited for all applications EXCEPT for the following:

- **Liquids containing abrasive solids that can break or scratch the surface of the glass electrode**

Exposing the glass electrode to the flow stream helps to "scrub" the glass electrode keeping it free of coating and debris from the process flow.

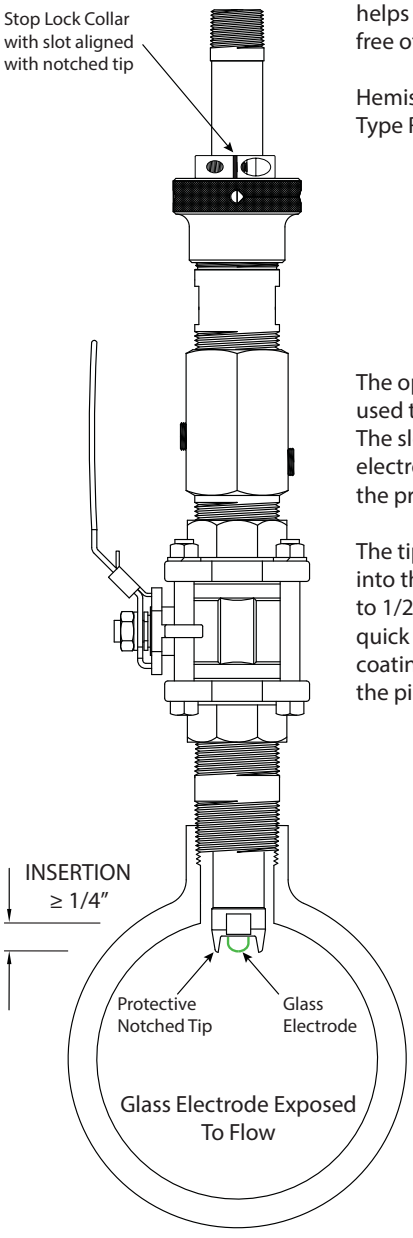
Hemispherical glass model codes include Type R, E, CE, CR, FR, & HR



Stop Lock Collar for 547 Sensor (B5106-0033)

The optional stop lock collar can be used to fix the sensor insertion depth. The slot can be oriented with the electrode tip to ensure alignment in the process.

The tip of the sensor should be inserted into the process approximately 1/4" (6mm) to 1/2" (12mm). This depth ensures quick measurement response, helps prevent coating issues, and avoids air pockets in the pipeline.



Front View

Side View

Figure 3

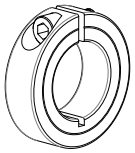
Hemispherical Glass Electrode Orientation Hidden from Flow

This special orientation of the sensor is only used in the the following appications:

- **Liquids containing abrasive solids that can break or scratch the surface of the glass electrode AND a flat glass electrode is not suitable due to high process temperature / pressure**

The notches at the tip are oriented facing the process to protect the hemispherical glass electrode from direct impact by particulates.

Hemispherical glass model codes include Type R, E, CE, CR, FR, & HR



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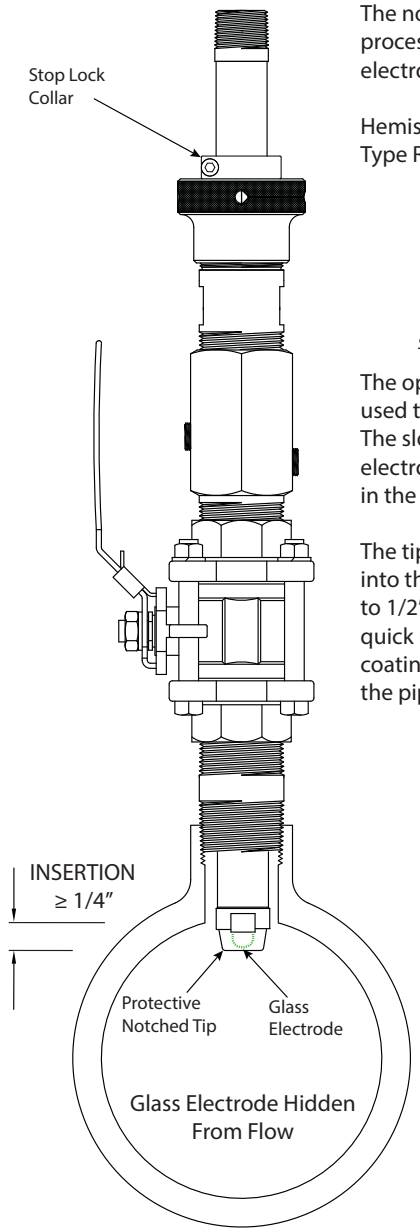


Front View

Side View

Figure 4

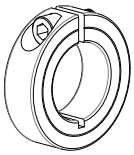
Flat Glass Electrode Orientation Exposed to Flow

This is the typical sensor orientation for flat glass electrodes. It is best suited for these applications:

- **liquids containing small size abrasive particulates (Examples - sand, catalyst fines, slurries, etc.)**

The flush design of the flat glass electrode prevents damage due to abrasion. Notches on the sensor body protect the glass electrode from direct impact by large particulates or damage during handling / installation.

Flat glass model codes include Type FG, CF, & FH



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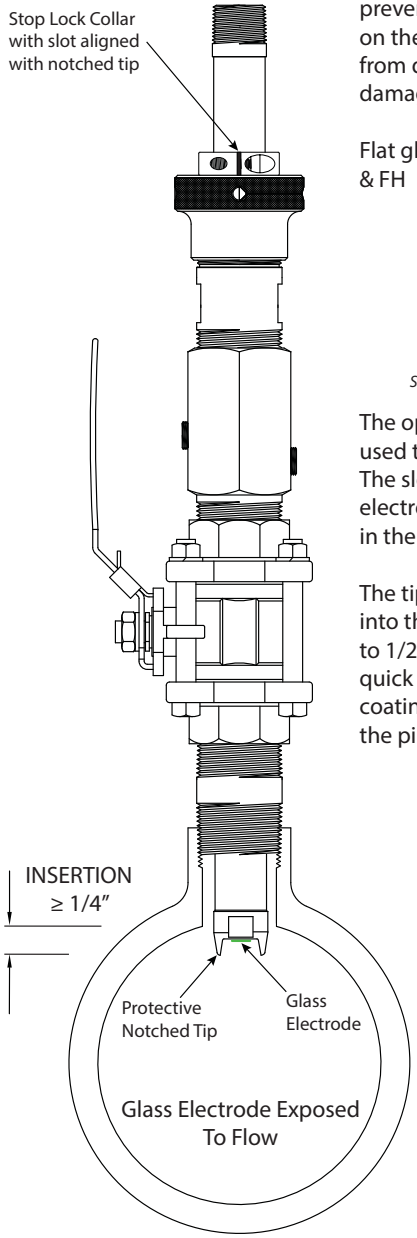


Front View

Side View

Figure 5

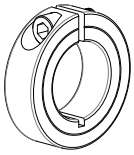
Flat Glass Electrode Orientation Hidden from Flow

This flat glass orientation is extremely rare. It is only used in special applications:

• liquids containing large size particulates (Examples - mining slurries, wood chips, heavy influent, etc.)

The main purpose of this orientation is to protect the electrode from physical damage (ie - breakage) due to large solids. The flow velocity should be kept as low as permissible while still entraining the solids in the stream.

Flat glass model codes include Type FG, CF, & FH



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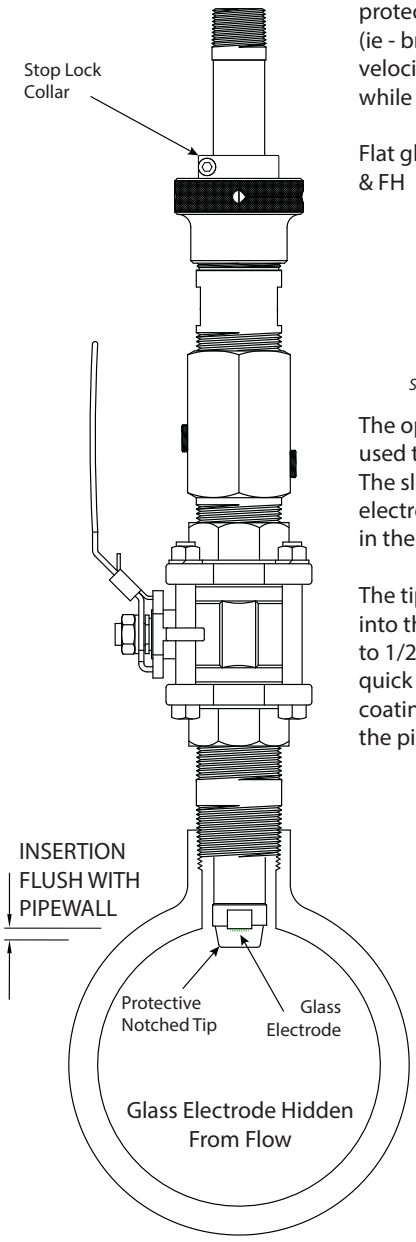

Front View

Side View

Figure 6

Submersible Installations

Chemical addition occurs in tanks and vessels thus it is common to require a submersible pH sensor to control the process. The pH sensor is normally mounted on the end of a dip tube that extends into the vessel. These applications can often be challenging due to coating and build-up on the sensor tip. Calibration and cleaning of the sensor may be less frequent due to the difficulty of removing the dip tube from the vessel. Changing liquid level within the vessel may expose the pH sensor causing it to dry out and lose sensitivity.

Because of the issues mentioned above, it is always preferable to install the pH sensor on a recirculation pipeline if available (Figure 7). The recirculation pipeline provides two important advantages.

1. Flow past the sensor tip prevents build-up from forming
2. The liquid has proper mixing ensuring accurate pH measurement.

If the sensor must be mounted in the vessel and coating is a concern then Barben offers several options to help clean off the sensor tip. Jet spray cleaners such as shown in Figure 8 can work with either air, water or cleaning solutions. They are effective for removing soft coatings such as fats, bio-films, and oils. Jet spray cleaners rely on force to remove the coating. They are less effective for hard "scale-like" coatings which must be dissolved.

Cleaning Options

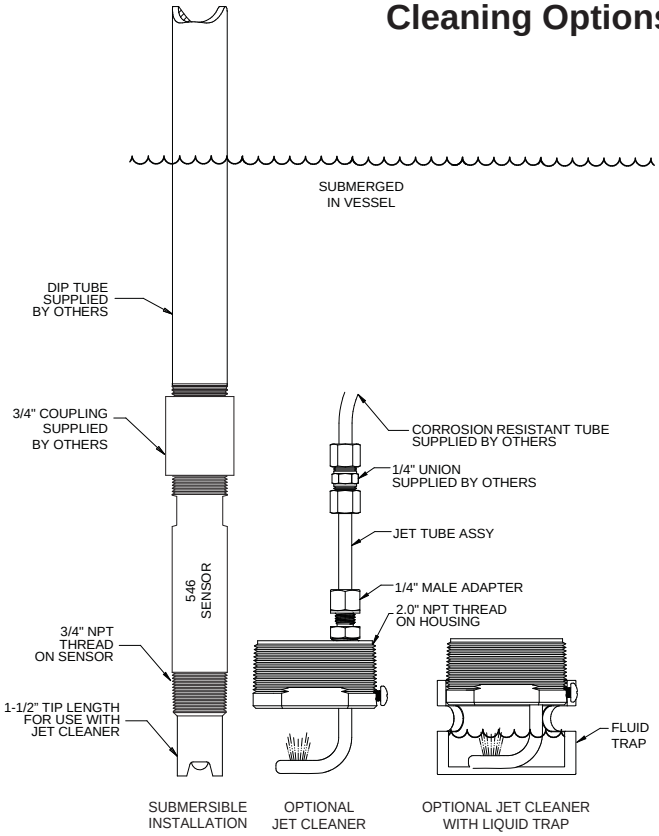

Figure 8

Submersible vs. Recirculation Installation

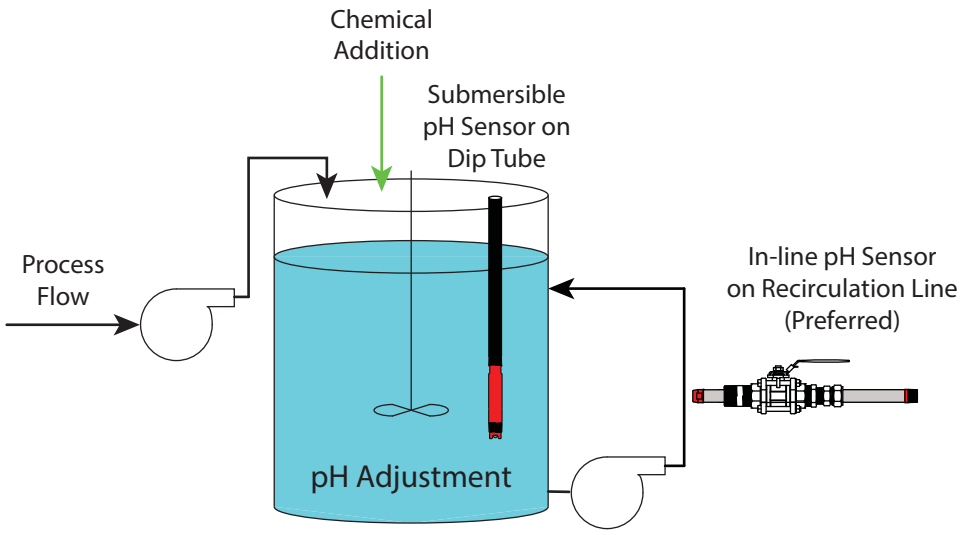

Figure 7

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Ametek has nearly 14,000 colleagues at over 120 manufacturing locations around the world. Supporting those operations are more than 80 sales and service locations across the United States and in more than 30 other countries around the world.

Barben Analytical
5200 Convair Drive
Carson City, NV 89706 USA

Toll Free:	+1 (800) 993-9309
Phone:	+1 (775) 883-2500
Fax:	+1 (775) 297-4740
Email:	Sales.Barben@Ametek.com
Web:	www.BarbenAnalytical.com