

pH Control of Boiler Water

Background

A major element of boiler water treatment is controlling corrosion by keeping the boiler water pH slightly alkaline. Alkaline pH causes an oxide film to form on the boiler tube surfaces that protects the base metal from further corrosion and allows breaks in the film to heal efficiently. pH control involves feeding sodium hydroxide and sodium phosphate salts in carefully controlled quantities. In common with most water treatments, overfeeding chemicals can do as much damage as underfeeding, so continuous monitoring of pH is an important part of the boiler chemical control program.

No pH sensor on the market can tolerate the temperature and pressures found in even the smallest industrial boiler. Therefore, the pH sensor must always be installed in a cooled and pressure-reduced sidestream sample. To prevent flashing, the sample cooler must be located upstream from the pressure reduction valve.

Choosing the Correct pH Sensor

The choice of a pH sensor for boiler water monitoring depends primarily on the conductivity of the boiler water. Conductivity can range from 7000 uS/cm in a low pressure industrial boiler to under 10 uS/cm in a high pressure boiler in a steam power plant. A pH sensor that works fine in a low pressure boiler will almost certainly fail in a high pressure boiler.

High conductivity boiler water

Choosing a sensor to measure the pH of high conductivity boiler water is fairly straightforward. As long as the conductivity is greater than 50 uS/cm at 25 °C and the suspended solids concentration is low, the 3900 is ideal. If the water has a high concentration of suspended solids, the 396P TUpH sensor is a better choice. The large surface area of the liquid junction in the TUpH sensor makes it more resistant to fouling than the 3900. However, the 396P should not be used in water having conductivity less than 100 uS/cm at 25 °C.

Low conductivity boiler water

The cutoff point between low and high conductivity boiler water is 50 uS/cm, which is the lowest conductivity at which a conventional pH sensor can reliably be used. Below 50 uS/cm the sensor of choice is the 3200 HP. It is specifically designed to measure pH in low conductivity water.

3200 HP Design Features

The major challenge in measuring the pH of low conductivity water is minimizing the difference between the liquid junction potentials in the calibration buffers and sample. The junction potential is the charge separation that arises when the reference electrolyte diffuses into the sample and the sample diffuses into the reference electrode. When a pH sensor is calibrated, the junction potential that develops in the buffers becomes part of the calibration. If the junction potential in the sample is different, the mismatch will cause an error in the measured pH. The amount of error depends largely on the sample conductivity. Roughly speaking, above 20 uS/cm, the error is minor, but at lower conductivity the error can be as much as 0.5 pH. Because the mismatch is caused by diffusion of sample into the reference junction, it can be eliminated by using a flowing junction. The outward flow of reference electrolyte from the electrode effectively blocks the sample from entering the junction. The 3200 HP uses a gravity-fed flowing junction. The error from the junction potential mismatch is less than 0.05 pH.

Although the flowing junction solves one problem it introduces another one. In low conductivity solutions, the potential of a flowing junction is often flow dependent. This means that changes in flow can alter the pH reading. Overcoming flow sensitivity is mainly a matter of keeping the sample flow as constant as possible in the fluid around the liquid junction. In the 3200HP a collar around the capillary disc and a diffuser plate in the bottom of the flow cell help reduce the variability in the flow. The 3200 HP sensor has practically no flow sensitivity when the flow is between 1 and 3 gph (60–180 mL/min).

Instrumentation

1056 Dual Input Intelligent Analyzer

- Single or dual input, multi-parameter instrument.
- Hart and Profibus DP digital communications.
- NEMA 4X (IP65) weatherproof, corrosion-resistant enclosure.
- Exclusive Quick Start screens for fast start-up and deployment.
- Two isolated current outputs.
- Easy to use intuitive menu structure with advanced diagnostics.
- Large display for easy-to-read process measurements.



1066 Transmitter

- Large display with easy-to-read process measurements, user-definable display of measurement diagnostic parameters.
- Digital communications – HART® version 7 and FOUNDATION™ fieldbus communication protocols available for host monitoring and configuration.
- Intuitive menu screens with advanced diagnostics and help screens.
- SMART enabled with automatic calibration with SMART pH sensors.



56 Analyzer

- Digital Communications: HART® and Profibus® DP communications with full features and functions.
- High Resolution full-color screen: easily viewed process measurements and on-screen data trend graphs.
- User help screens: detailed instructions and troubleshooting in multiple languages.
- Data logger and event logger: download process data and alarm conditions with time and date stamps via USB 2.0 data port.
- Control - PID and time proportional capabilities. Also includes synchronize interval timers and four special application functions.



3200 HP High Purity pH Sensor

- pHaser® laser drilled capillary liquid junction resists signal drift.
- Unique sensor design provides accurate, stable, pH measurement in high purity water.
- Electronically shielded glass electrode protects against electrostatic noise pickup.
- Simple maintenance requiring only bimonthly replenishment of electrolyte solution.



3900 pH Sensor

- Enhanced performance and increased life provided by field-proven AccuGlass™ pH glass formulations.
- New ¾" and 1" mounting solutions to meet a variety of application installation requirements.
- Extended sensor life provided by double junction reference.
- Maximum chemical resistance provided by rugged polyphenylene sulfide body, completely sealed to eliminate sensor leakage.
- Operates in temperatures down to -10 °C (14 °F) and up to a maximum of 100 °C.



396P TUpH™ pH Sensor

- Minimum sensor maintenance due to patented TUpH reference technology which ensures steady pH signal when sensor is coated.
- Maximum sensor life due to helical reference pathway which hinders reference poisoning.



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