

Highest Production Safety with X-Chip Technology pH Sensors

Thanks to breakthrough X-Chip™ technology, InPro™ X1 pH sensors are unbreakable, enabling in-line pH measurement in applications with the highest product safety requirements. Measuring in-line enables better process control, leading to higher product quality and increased yield. InPro X1 sensors are sanitizable using standard industrial processes without the need of expensive and maintenance-heavy retractable equipment. The InPro X1 complies with all relevant standards for the food and beverage industry and can be easily implemented with the same Standard Operating Procedures valid for glass pH electrodes.

Typical pH measurement challenges in the food and beverage industry

pH measurement is used in a plethora of industrial processes for monitoring product quality, increasing process efficiency, ensuring plant safety or monitoring wastewater. Until recently, glass-bulb pH sensors provided the most reliable measurement performance. However, challenges with glass electrodes correlated with their need for frequent calibration and poor mechanical strength has limited their



use in the production of beverages, dairy products and other foods.

Regular maintenance of pH sensors is necessary for maintaining measurement reliability: cleaning to prevent fouling and buildup of material that can interfere with sensor performance, and calibration to correct for measurement drift.

It is exposure to high temperatures (cleaning-in-place) and/or harsh conditions that cause the most drift of a pH sensor's measurement signal, therefore shortening required maintenance intervals. The more often maintenance on sensors is performed, the higher the operating costs.

A pH sensor failure due to glass breakage will, in the best case, cause production downtime. At worst it can lead to expensive rework or even discarding of an entire production batch because of contamination of the product with glass splinters. Understandably, in the food and beverage industry, the use of in-line glass electrodes is only permitted in non-critical processes.

No risk of glass contamination

As a response to industry challenges, METTLER TOLEDO has developed a new technology for measuring pH: the X-Chip.

X-Chip is a fully solid pH sensing element with exceptional mechanical resistance. The X-Chip uses the same potentiometric measurement principle as pH-sensitive glass normally used in pH sensors.

The surface of the X-Chip is in contact with the measuring

solution. Here, as in traditional electrodes, a gel layer forms where H^+ ions can diffuse, creating a charge the level of which is dependent on the pH value of the medium (the potential of this surface is proportional to the pH of the measurement solution).

In order to have a reliable measurement, the inner surface of the sensor's pH-sensitive layer has to be kept at a stable potential, this way the difference in potential between the two surfaces is only dependent on the pH value of the measurement media. In traditional electrodes this fixed potential is achieved by filling the glass bulb with an inner buffer which maintains a constant pH value.

The X-Chip achieves the same result without any liquid buffer. Instead, it uses different solid layers. Diffusion bonding ensures perfect adhesion of all layers, and as a result, the X-Chip is mechanically very stable and cannot shatter. As with traditional glass electrodes, the X-Chip design features a reference electrode to enable it to measure pH precisely.

Improvements in measurement performance

InPro X1 is the first pH sensor to feature X-Chip technology. It has a pre-pressurized liquid electrolyte which ensures

accurate and consistent measurement throughout the sensor's lifetime.

Because the measurement principle in the InPro X1 is the same as for traditional glass pH sensors, the new design has a linear measuring range that spans from pH 0 to 14 with a theoretical slope of -59.16 mV/pH at 25°C , as defined by the Nernst equation (see Figure 2). Temperature compensation is also based on the same theoretical principle as glass-bulb electrodes.

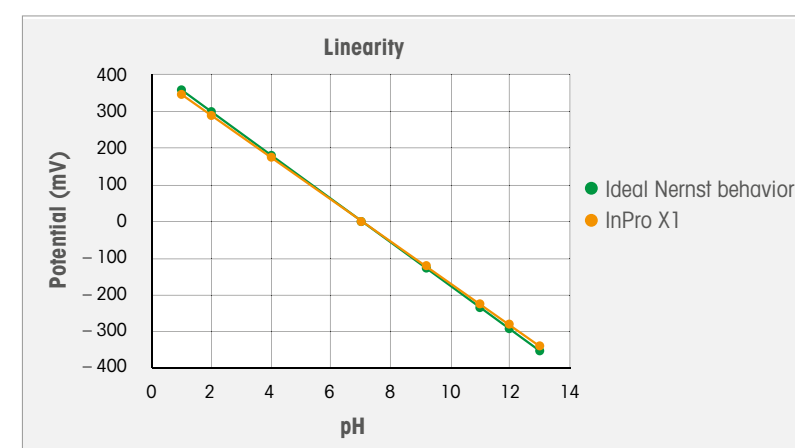


Figure 2: Measurement performance of InPro X1 electrode with pre-pressurized liquid electrolyte.

As mentioned, one of the sources of drift in traditional pH sensors is the inner buffer solution. Over time, the solution reacts chemically with the pH-sensitive glass, causing a shift in the chemical composition of the buffer and resulting

in a drift in the measurement signal. This phenomenon is negligible at low temperatures but its kinetics, and therefore measurement error, becomes relevant at high temperatures. There is no inner buffer in the InPro X1 pH sensor, so it exhibits much lower drift at elevated temperatures.

Due to the significantly reduced drift, sensor calibration intervals can be extended by up to 100%, allowing cost savings in human intervention and maintenance.

X-Chip is produced through strictly controlled, highly engineered processes, ensuring excellent reproducibility from sensor to sensor. The result is consistent results through each sensor's lifetime and between different sensors.

On-board intelligence

InPro X1 sensors feature METTLER TOLEDO Intelligent Sensor Management (ISM™) technology. ISM is a digital platform for in-line process analytics that increases process reliability and simplifies compliance.

Every ISM sensor carries an onboard microprocessor. It is this that allows ISM to deliver benefits and a level of performance that analog systems simply cannot provide, including the ability to calibrate the sensor away from the

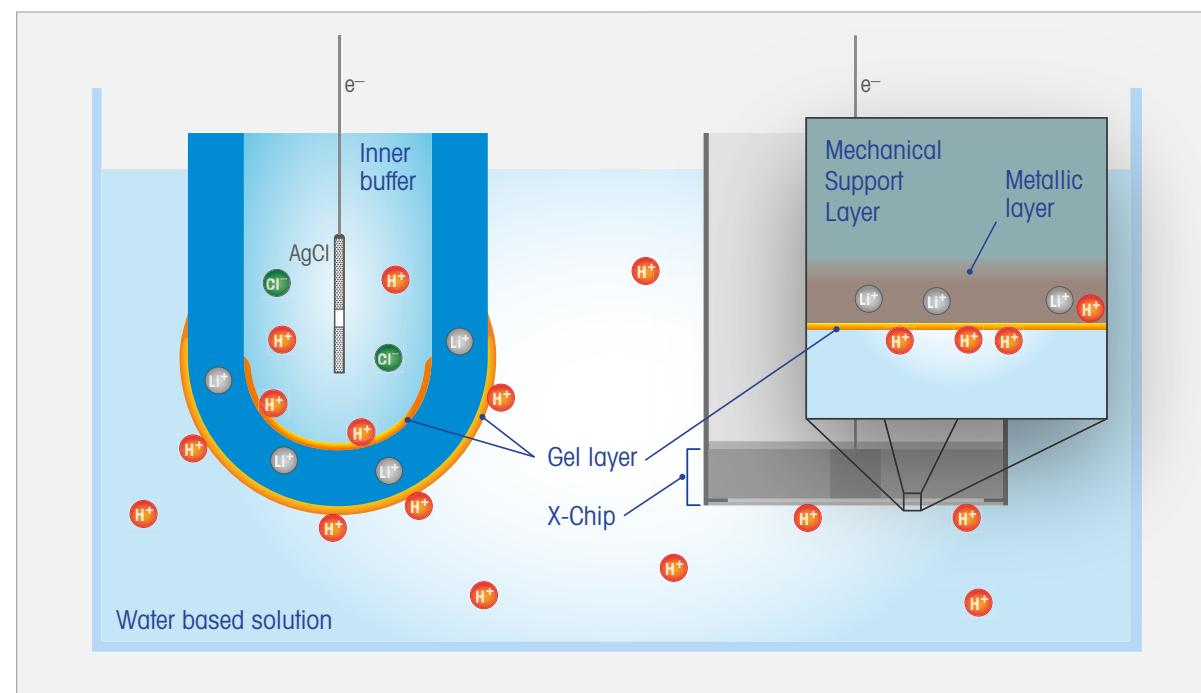
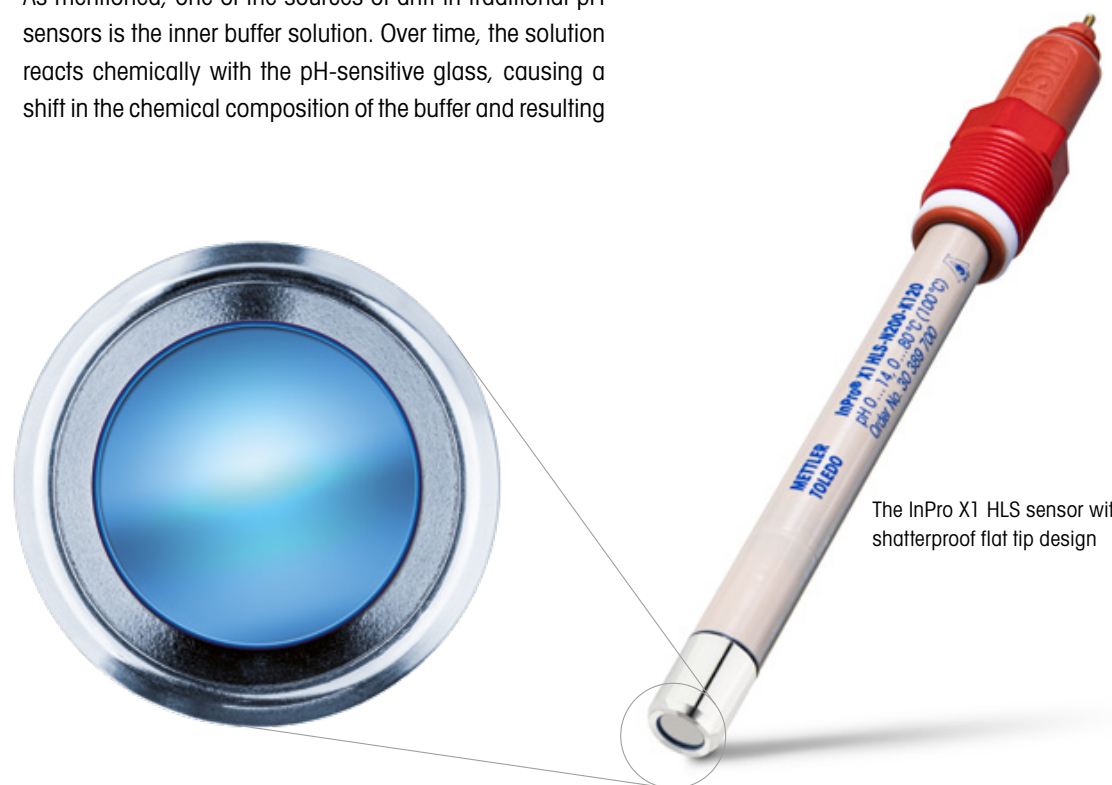


Figure 1: pH measurement technology innovation in the InPro X1 tip in comparison with traditional glass pH electrodes



The InPro X1 HLS sensor with shatterproof flat tip design

process, high signal stability, electronic signatures for regulatory compliance and advanced diagnostics that predict when sensor calibration or replacement will be required.

Backwards compatibility to existing pH loops

InPro X1 pH sensors have the 12 mm diameter of traditional glass electrodes and therefore can be installed on the same housings. Calibration (1-point, 2-point and process) and maintenance requirements are the same as for analog or ISM sensors, enabling a smooth transition into the new technology without SOPs being affected.

Also, they do not have any special technical requirements compared to already existing ISM sensor installations, enabling the same cables and transmitters to be used to complete a measurement system.

High temperature tolerant

Contrary to available glass-free pH technologies such as ISFET, the InPro X1 is resistant to cleaning-in-place (CIP) procedures. In applications where CIP is used daily, the InPro X1 can be installed without the need for expensive retractable equipment, offering the same degree of process safety as non-glass sensors but with improved measurement performance.

Conclusion

The fragility of traditional glass pH sensors has prevented them from being used more widely than they currently are, and their need for regular calibration has been associated with increased operating costs. The unique design of the METTLER TOLEDO InPro X1 with X-Chip technology provides an exclusive solution to both issues. It offers worry-free, high accuracy pH measurement in food and beverage applications where glass-bulb sensors have previously been unsuitable.

► www.mt.com/InProX1HLS

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