

FAQ –INDUSTRIAL VS LABORATORY SENSOR

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Can I utilize a Turtle Tough Sensor for laboratory or small-scale operations?

Rationale behind Turtle Tough's recommendation against using our sensors for laboratory or pilot scale applications.

While it may be tempting to employ an industrial sensor to benefit from its longer lifespan and improved durability compared to a laboratory electrode, there are several significant challenges that must be taken into account before adopting this approach. Laboratory electrodes often prove inadequate in enduring the demanding conditions encountered in many laboratory and pilot scale endeavours. These electrodes are delicate, susceptible to breakage, fouling, and contamination, sometimes lasting only a few days. However, they offer an exceptionally high level of accuracy. Customers seeking a more reliable solution often consider industrial sensors, but it is important to acknowledge that no choice comes without compromises or sacrifices. Therefore, the practicality of adapting an industrial sensor to a small-scale environment necessitates careful consideration of various factors.

Size

Turtle Tough sensors are intentionally designed to be larger in size due to their underlying technology. The incorporation of a larger reference element ensures extended longevity and exceptional resistance to process contamination. Additionally, the larger surface area helps reduce fouling, minimizing the need for frequent cleaning. The use of our ULTRA TOUGH break-resistant glass element requires a minimum size to maintain mechanical strength and electrical properties. The technology utilized in our sensors is directly correlated with their size and surface area. Therefore, it is not possible to make them smaller without compromising their intended functionality. The sensor body also needs to accommodate various components such as the glass element, sealing components, and smart sensor technology. However, the size of the sensor poses challenges when it comes to integrating them into small-scale equipment and component designs. Laboratory electrodes, for example, typically have a diameter of 12mm, and most lab or pilot scale setups are designed to accommodate this specific dimension. Attempting to incorporate an industrial sensor into such an environment often requires significant modifications.

Installation Issues

The size and technology of Turtle Tough sensors can lead to installation challenges. The sensor dimensions can be referenced in our brochures and specification pages, highlighting their substantial size compared to lab electrodes. Our Inline sensor, for instance, requires a minimum pipe size of 1.5 inches (preferably 2 inches), and even our smallest inline fitting necessitates a mating fitting with 1" MNPT threads. In table-top applications, even our smallest sensor may struggle to fit into a 500ml to 1L sized beaker, particularly when considering the presence of other equipment such as additional sensors or stirrers.

Electrical Issues

Electrical interference resulting from dirty power or ground loops is a common installation issue. Lab and pilot scale applications often lack proper grounding and isolation measures for electrical equipment, such as pumps, drives, stirrers, and heaters. The electrical infrastructure in these settings may not be equipped to accommodate an industrial pH/ORP sensor effectively. In contrast, large industrial environments with extensive metal tanks or pipework provide numerous pathways for stray currents, which can be detrimental if they bypass the sensor. The unique design of our sensors incorporates a sizable (5 inches long, 1 inch in diameter) solid-state, non-porous conductive reference

system, which acts as a lightning rod for stray currents. This reference system contributes to the success of our products in challenging applications, providing resistance to fouling, contamination, and exceptional longevity. However, it necessitates proper electrical installation, which is often discovered after sensor installation. Few instruments demand as much attention to electrical installations as pH sensors due to their sensitivity. It is crucial to note that even tiny amounts of voltage fluctuations can result in offset and erroneous readings, considering that 1 pH unit corresponds to approximately 59mV, 0.1 pH units to 5.9mV, and 0.01 pH units to 0.59mV.

Materials of Construction

Laboratory equipment and pilot plant constructions are often made from glass or plastic materials. These materials, unlike large steel structures found in industrial installations, do not provide the necessary grounding capabilities to eliminate static and stray currents from the environment. As a result, they can significantly impact the stability of pH measurements, presenting challenges when using industrial sensors in these settings.

Proximity

In laboratory and pilot installations, the close proximity of equipment introduces the possibility of interference from neighbouring devices. Any high-current equipment has the potential to generate electromagnetic fields (EMF) that can disrupt pH measurements. Additionally, the presence of active electrodes, such as conductivity, dissolved oxygen sensors, or flow meters, in close proximity to passive sensors like pH or ORP can result in minor offsets or even produce significant measurement errors, including off scale readings. It is important to be aware of these proximity-related challenges when considering the placement of industrial sensors in such environments.

Accuracy

Industrial sensors and laboratory electrodes are fundamentally different in design, akin to comparing a robust tank to a nimble race car. Industrial sensors are built with thick glass membranes and high impedance solid-state reference systems, providing exceptional durability. They prioritize longevity and minimal drift over time, ensuring superior process control outcomes rather than absolute accuracy. In contrast, laboratory electrodes feature thin and delicate glass membranes and low impedance reference junctions, offering low noise and high precision akin to a race car. While laboratory electrodes can provide accuracy up to the third decimal place, their performance quickly deteriorates in demanding environments, rendering their measurements unreliable within a matter of hours due to contamination. Industrial sensors, while not achieving the same acute accuracy as their laboratory counterparts, remain stable for extended durations, facilitating consistent process control. Any concerns regarding absolute accuracy can be addressed through proper calibration techniques. It is important to note that industrial electrodes do not have a universally stated accuracy, as it heavily depends on the specific application. Claims of accuracy are based on laboratory speculations under ideal conditions with perfectly clean and stable standards, which do not fully capture the real-world challenges faced by electrodes. As the measurement moves further away from pH 7, and from standard temperature and pressure conditions, the measurement uncertainty increases. Furthermore, as the sensor ages and its response rate diminishes, the absolute accuracy also decreases. In severe applications, an accuracy up to the first decimal place can be expected at best.



Laboratory vs Industrial Electrode

Consider the following image:

- Pictured on the left are 2 glass laboratory electrodes, ORP and pH. The red circle at the tip of the sensor is indicating the junction area within the sensor.
- Pictured to the right are 3 industrial Turtle Tough Electrodes. The sensor on the far right of the image has been dissected in half to reveal the inner construction of the sensor. The red circle is indicating the full size of the junction area in a solid state reference electrode.



Comparison of the reference electrode

The primary function of the junction material is to provide a pathway for ion exchange between the sample being measured and the reference electrode. The reference electrode is filled with a stable reference solution that maintains a known pH value. By allowing the passage of ions, the junction material ensures that there is a continuous electrical connection between the reference solution and the sample solution, enabling the measurement of the pH. The junction material is usually a porous material, such as ceramic or glass, with microscopic openings or pores. These pores allow the movement of ions while minimizing the flow of liquid between the reference electrode and the sample. Additionally, the junction material also serves to prevent direct contact between the reference electrode and the sample solution. This physical separation helps avoid potential chemical reactions or interferences that could affect the accuracy of pH measurement.

With respect to using a laboratory sensor in industrial applications, the **use of a liquid junction and small reference material in pH sensors can lead to several challenges and problems**. Some of these issues include:

- **Clogging and Fouling:** The liquid junction, which is typically a small opening or capillary tube, can become clogged or fouled due to the presence of particles, precipitates, or contaminants in the sample solution. This can impede the flow of ions and result in inaccurate pH measurements or even complete sensor failure. Regular maintenance and cleaning may be required to address this problem.
- **Maintenance and Replacement:** The small size of the reference material in the electrode may require more frequent maintenance and replacement compared to larger reference materials. This can lead to increased downtime and maintenance costs in industrial settings.
- **Reference Junction Potential Variations:** The liquid junction can introduce variations in the reference junction potential, which is the voltage established at the interface between the reference electrode and the sample solution. These potential variations can occur due to changes in the composition or concentration of ions in the sample solution or as a result of temperature fluctuations. Uncontrolled reference junction potential variations can lead to measurement errors and inaccuracies.
- **Contamination and Electrolyte Leakage:** In certain industrial environments, there may be a risk of contamination or electrolyte leakage from the reference electrode. This can occur if the liquid junction or the reference electrode itself is damaged or compromised. Contamination or leakage can affect the accuracy and reliability of the pH measurement and potentially contaminate the process or sample being monitored.

To address these challenges, alternative pH sensor designs, such as solid-state reference electrodes are often employed in industrial applications. These designs offer improved reliability, more reliable response times, reduced susceptibility to clogging or fouling, and greater long-term stability compared to liquid junction and small reference material configurations.

Industrial sensors with solid-state references offer several benefits compared to sensors with liquid junctions and small reference materials. Some of the advantages of industrial sensors with solid-state references include:

- **Enhanced Stability and Longevity:** Solid-state references provide greater stability and durability compared to liquid junctions. They are less prone to clogging, fouling, or electrolyte leakage, ensuring consistent and reliable pH measurements over extended periods. This characteristic reduces the frequency of maintenance and replacement, resulting in cost savings and increased productivity.
- **Reduced Reference Junction Potential Variations:** Solid-state references offer improved resistance to variations in reference junction potentials. They are less affected by changes in ion concentration or temperature, resulting in more stable and accurate pH measurements.
- **Minimal Contamination Risk:** Solid-state references eliminate the risk of electrolyte leakage or contamination, as there are no liquid components involved. This feature ensures the integrity of the sample being monitored and avoids potential adverse effects on the industrial process.
- **Compatibility with Harsh Environments:** Industrial sensors with solid-state references are better suited for harsh environments that may involve high temperatures, pressure, or corrosive substances. They can withstand these challenging conditions without degradation in performance, making them suitable for a wide range of industrial applications.



- **Lower Maintenance Requirements:** Due to their robust design and resistance to fouling or clogging, solid-state reference sensors generally require less frequent maintenance and cleaning compared to liquid junction sensors. This reduces downtime and operational costs associated with sensor upkeep.
- **Long-Term Calibration Stability:** Solid-state references offer excellent long-term calibration stability, meaning that they maintain their accuracy over extended periods without significant drift. This characteristic is particularly important in industrial settings where consistent and reliable pH measurements are crucial for process control and quality assurance.

Overall, industrial sensors with solid-state references provide improved stability, faster response times, reduced contamination risk, and enhanced longevity compared to sensors with liquid junctions and small reference materials. These benefits make them a preferred choice in industrial applications where accurate and reliable pH measurement is essential.

