pH Measurement Basics

How to Measure pH
In TRIS-Containing Samples

Summary
TRIS buffers, which are often present in biological samples, can cause challenges in pH measurement. The interaction between classic electrolyte solutions and the key components of the TRIS base leads to junction blockage and shortened sensor lifespan. Selection of the appropriate reference system can allow improved sensor accuracy and extended lifetime.

The Standard Silver / Silver Chloride Reference System

Any pH measurement requires two electrodes: a glass sensing electrode, and a reference electrode. Commonly, pH sensors in use today are so-called 2-in-1 sensors, meaning that both the sensing and reference electrodes are housed in the same sensor.

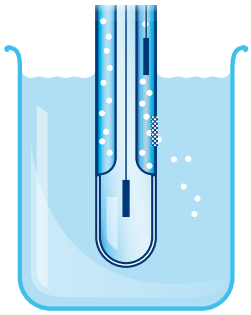

Figure 1: Reference and measuring sensor combined in a 2-in-1 sensor

The most commonly used reference system in pH measurement is silver/silver chloride. A conventional silver/silver chloride reference system is comprised of a silver wire coated with silver chloride and a reference electrolyte which is in contact with the solution of interest through a junction.

For this construction, it is important that the reference electrolyte be saturated with silver chloride, so that the silver chloride is not depleted and stripped from the wire. In order to maintain a constant potential, the silver chloride must not be depleted, and the junction must allow the flow of ion-rich electrolyte into the sample.

The Challenge of Measuring TRIS-Containing Samples

Ordinary silverchloride sensors cannot be used for measuring TRIS samples. Many compounds are known to bind with silver ions to create large molecules or precipitates. In fact, silver chloride itself is one such precipitate, with limited solubility in aqueous solutions. Another such compound is formed between silver ions and TRIS molecules, commonly found in biological buffers.

Silver ions in a standard reference electrolyte solution flow into the sample of interest. If that sample contains a TRIS buffer, those two species will meet to form a stable, precipitating complex. Unfortunately, the point

Figure 2: Left to right: clean junction (white "dot") in front of a black temperature probe and contaminated junction (black "dot")

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where this precipitate forms is typically the reference junction, which is a small ceramic frit with microscopic pores. This precipitation reaction clogs the pores in the junction, preventing electrolyte from flowing out. Once this process occurs, the interface between the sample solution and the reference system is eliminated, and the reference system can no longer generate a constant potential. This introduces unstable and erroneous pH readings.

How to Measure TRIS Containing Samples

One way to prevent the loss of sensor performance due to silver precipitation reactions is to explore alternative junctions. Although it will not prevent the precipitation reaction from occurring, a junction that does not consist of small pores will not be susceptible to clogging.

One such junction is the sleeve junction. This junction consists of a relatively large hole that is covered by a ground glass or plastic sleeve. The sleeve can be moved to regulate the flow of electrolyte. It can also be easily cleaned, which will remove any contamination by silver precipitates.

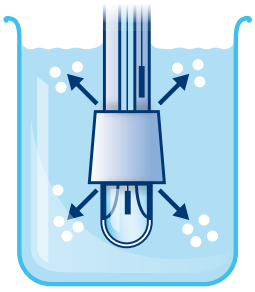

Figure 3: InLab® Science PRO-ISM sleeve junction

Alternatives to the ceramic fritted junction are not always feasible, however. For instance, micro sensors used to measure small sample volumes are too small to have useful sleeve junctions. Alternative junctions may also add to the cost of a pH sensor due to the difficulties in manufacturing of such sensors.

The ARGENTHAL™ Reference System

An improvement to the classic silver/silver chloride reference system is METTLER TOLEDO's ARGENTHAL system. Like classical reference systems, it consists of a silver wire coated with silver chloride and a reference electrolyte. However, the ARGENTHAL system also contains a small cartridge filled with silver chloride particles that provide silver ions for the reference system. The ARGENTHAL system comes in combination will a silver ion barrier, which prevents silver from migrating into the electrolyte. The cartridge will last for the life of the sensor.

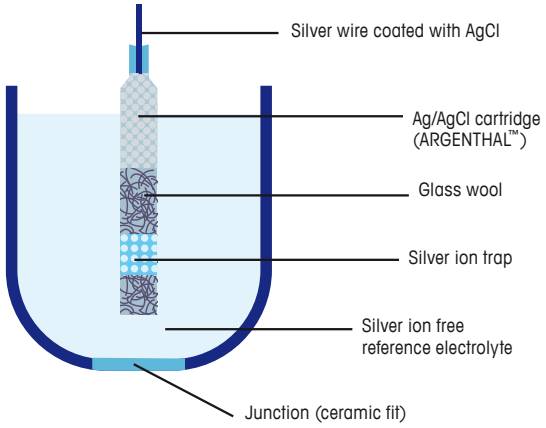

Figure 4: Schematic construction of the ARGENTHAL system

Since the ARGENTHAL's silver chloride cartridge provides silver ions to the reference system, the reference electrolyte is no longer required to contain silver chloride. The result is that silver ions are no longer released into the sample. Risk of silver-TRIS complexes clogging the junction is eliminated.

The majority of METTLER TOLEDO sensors employ the ARGENTHAL reference system. Standard sized sensors (InLab Routine Pro-ISM), those with sleeve diaphragms (InLab Science Pro-ISM), and micro sensors (InLab Micro Pro-ISM) are available for life sciences applications.

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