pH Application Note

pH Measurement of Yogurt

InLab Solids Pro-ISM Sensor

Accurate pH measurement in yogurt manufacturing and quality control is critical for maintaining product quality. Yogurt presents a number of challenges to the typical pH sensor with ceramic junction due to its interaction with functional sensor components, and in turn contributes to inaccurate and sluggish results. By adjusting the sensor design, like in METTLER TOLEDO's InLab Solids Pro-ISM, the functional components of the sensor are modified to handle measurement challenges of yogurt and other similar semi-solid samples. Ultimately, faster and more accurate results are obtained.

METTLER TOLEDO

Introduction

Yogurt is an immensely popular dairy product due to its nutritional and therapeutic properties. It acts as a probiotic carrier due to the presence of live bacteria strains. The lactose sugar in milk is converted to lactic acid by these 'good' bacteria in a process called fermentation. The pH of milk drops from 6.7 to less than or equal to 4.6 pH units and is an important step in the yogurt manufacturing process.

Typically, the processing steps involves homogenization, pasteurization, and cooling to incubation temperature before starter culture is added. The fermentation process begins with the addition of the live bacterial strains at optimum temperature. The reduction in pH due to lactic acid formation is monitored and controlled until the desired pH is achieved as pre determined by the manufacturer (below 4.6 pH units). Later, it is partially cooled (below 20 °C) and then fruit or flavoring ingredients as per requirement are added. The product is then transferred to cold storage, which reduces further acid development.

A correlation between the pH of post storage yogurt and survival of probiotic bacterial strains serves as an indicator of the shelf life of the yogurt products.

Importance of measurement

The probiotic benefits, taste and shelf stabilitly of yogurt samples all depend on accurate pH measurements throughout manufacturing and quality control processes.

The measurement is performed during production to monitor the progress of fermentation and in quality control to confirm product consistency in terms of flavor and shelf stability. Unfortunately, pH measurement in the final product can be a challenging endeavor; the protein and fat in the sample can foul pH electrode components, leading to sluggish and often inaccurate results. Erroneous pH results have a negative impact on final product quality.

Measurement Challenges

Two critical principles govern the efficacy and accuracy of pH measurement: the sensing glass of the pH electrode must freely interact with the sample, and reference electrolyte from the sensor must mix with the sample at the time of measurement. If either of these criteria is not met, the user will experience unstable and slow measurement results.

The table below outlines the challenges and negative effects on pH measurement results when using a typical sensor.

Sample Challenge	Sample Impact
Semi-solid sample material	Insertion into the sample is difficult which may damage the sensor.
High protein sample content	Sensor junction damage due to clogging, causes inaccurate results.
High fat sample content	Sensor fouling due to deposition on the glass membrane, causes sluggish response.

Yogurt's high fat and protein content accumulate on the sensor's glass, thereby preventing the sample from interacting with the membrane to initiate a signal. Further, when proteins from the sample interact with reference electrolyte, the proteins precipitate. When such precipitation occurs, a typical ceramic fritted junction will clog, preventing electrolyte from mixing with the sample and thereby causing measurement error.

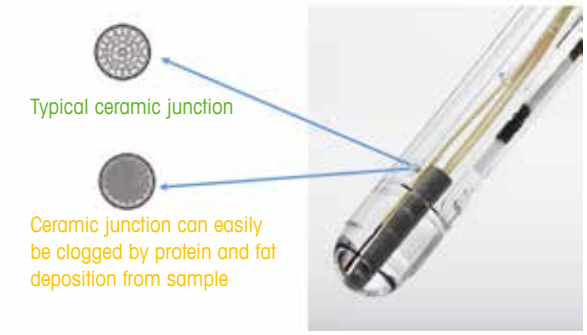

Figure 1: Sample impact on a conventional pH sensor having a ceramic junction

Finally, the semi-solid nature of most gelled yogurts can introduce sample-handling challenges for the user. Delicate sensing membranes can be broken during the measurement process. For this reason, some labs turn to indirect measurement techniques, wherein the sample is diluted with water prior to measurement. However, the dilution process affects the pH measurement results, yielding inaccuracies. The most accurate method of pH measurement in yogurt is direct measurement, where the sample remains undiluted.

InLab Solids Pro-ISM for reliable pH

The InLab Solids Pro-ISM (51344155) is a specialist sensor for measuring the pH of yogurt with accuracy and precision. The sensor has a built-in temperature probe and provides Intelligent Sensor Management (ISM) technology, allowing users to accurately capture all critical measurement parameters.

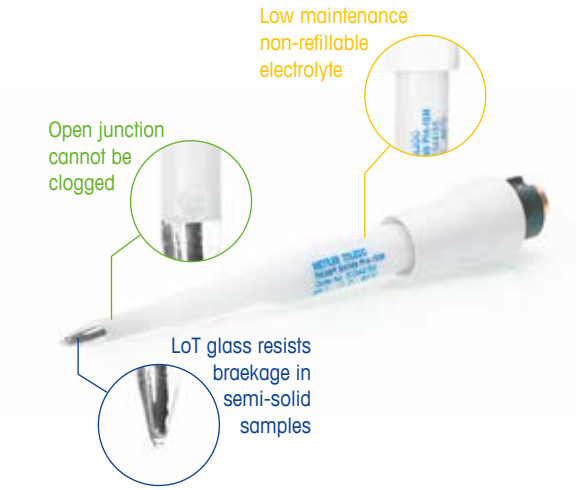

Figure 2: InLab Solids Pro-ISM pH sensor

The pH sensing membrane is constructed from low temperature (LoT) glass, which yields fast results and is resistant to breakage. The solid XEROLYT®EXTRA polymer reference system offers two benefits: it is low maintenance, and has a clog-free open junction, which eliminates the risk of protein fouling. The specialized design and overall sensor technology of the InLab Solids Pro-ISM ensures direct sample measurement of semi-solid yogurt, without sample dilution. This direct measurement capability is important for obtaining the most accurate results and ensuring reliability and consistency in the manufacturing and quality control of yogurt.

Procedure and Method

Calibrate the sensor using buffers that bracket the anticipated pH value of the sample (in this case pH 4.01 and 7.00). Record the calibration slope and offset value for the electrode. A slope value of 95 -105 % and an offset of 0 ± 30 mV ensures reliable measurement.

Measure the pH of the yogurt sample with InLab Solids Pro-ISM pH sensor by immersing the electrode tip into the sample, ensuring that the electrolyte junction is also immersed. Repeat the measurement in triplicate. A standard deviation within ± 0.05 pH units indicates acceptable variance in pH measurement of the sample. Between samples, clean the electrode with a mild soapy solution and rinse with DI water to remove protein and fat buildup from the glass. Occasionally, for thorough cleaning of the sticky residues from the electrode surface, clean it with Ethanol or acetone and later rinse it with de-ionized water.

Figure 3: Measuring pH of a yogurt sample using InLab Solids Pro-ISM

Results and Discussion

Typical measurement results for yogurt samples.

Sample	Mean pH Value	Std.Dev.	Avg. time (s)
Yogurt (plain)	4.199	0.01	18
Raspberry flavored	4.005	0.01	12
Blueberry flavored	4.103	0.01	07
Strawberry flavored	4.045	0.01	18

Expert Tips

- Periodic reconditioning of the electrode in 0.01M HCl is recommended, based on the sensor performance. Frequency of reconditioning would depend upon the number of samples analyzed per day and life of the sensor. More frequent conditioning is needed for an old sensor compared to a newer sensor. Remember to re-calibrate the sensor after reconditioning.
- In between measurements or when the electrode is not being used for brief period, it is best to keep the electrode in wetting cap filled with InLab Storage Solution (30111142).
- Ensure use of correct buffers in the correct sequence. Always use fresh buffers. Check the expiry date.
- It is recommended to soak the sensor in pepsin/HCl solution (51350100) for one hour to remove protein build up on the glass membrane. Recommended frequency is once a fortnight or depending on the sensor performance. Sluggish response or inaccurate results indicate contamination of the glass membrane.
- The pH range for this sensor is 1 to 11 pH units and hence should not be exposed to harsh acidic (below pH 1.00) or alkaline (above pH 11.00) solutions.
- Electrode handling movies on:

YouTube

- Comprehensive range of pH meters, electrodes, solutions, and accessories:
  www.mt.com/pH

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Mettler-Toledo GmbH, Analytical
Im Langacher 44
8606 Greifensee, Switzerland
Tel. +41 22 567 53 22 / Fax +41 22 567 53 23

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