pH Application Note

pH Measurement of Cheese

InLab Solids Pro-ISM Sensor

Accurate pH and temperature measurement is critical in cheese manufacturing and quality control to ensure the final product has the desired texture, flavor and shelf-stability. The conventional pH sensor, which has a ceramic junction, can pose various challenges in pH measurement of cheese samples. The solid nature and high protein - fat content of cheese can lead to sensor damage and inaccurate or sluggish results. By modifying the sensor design, like those in METTLER TOLEDO's InLab Solids Pro-ISM, the functional components of the sensor are adapted to handle measurement challenges of cheese and other similar semi-solid samples. This application note discusses the importance of pH in the manufacturing of cheese with a special focus on the pH measurement of the final product.

METTLER TOLEDO

Introduction

The cheese manufacturing industry relies on pH monitoring of products to ensure quality, flavor, and texture. From the initial pH measurement during acidification of milk, to the final measurements of ripened cheese, pH is an important control parameter for achieving the desired batch consistency.

Each cheese variety differs in composition, which means method preparation and technique will vary. Milk is fermented under controlled conditions by microbial cultures to produce lactic acid. This decreases the pH and helps in the development of flavor. After the curdling process, the supernatant liquid whey is drained. The pH value of the whey at drainage is specific for the cheese variety being processed. Liquid whey with a high pH correlates to a high calcium content. For example, Swiss cheese types are normally drained at a high pH and have high calcium content compared to a cheddar cheese. The next stage involves milling and salting, which are both influenced by the pH value. A lower pH during milling produces a harder cheese and a lower pH during salting results in higher salt absorption. After being milled and salted, some cheese varieties ripen by biochemical processes that can also affect the final pH value. Proteolysis during this ripening process, for example, leads to an increase in pH.

Importance of measurement

Measuring of pH at each stage of the cheese making process ensures the desired quality of the final cheese product. The pH value acts as a proxy for microbial culture activity and is one of the deciding factors for the physicochemical, biochemical, microbiological, and sensory properties of cheese. These parameters form the characteristic flavor and texture of the cheese. A correlation between pH and mineral (calcium) content of cheese was observed in a scientific study carried out by Lawerence et.al., as shown in the figure below.

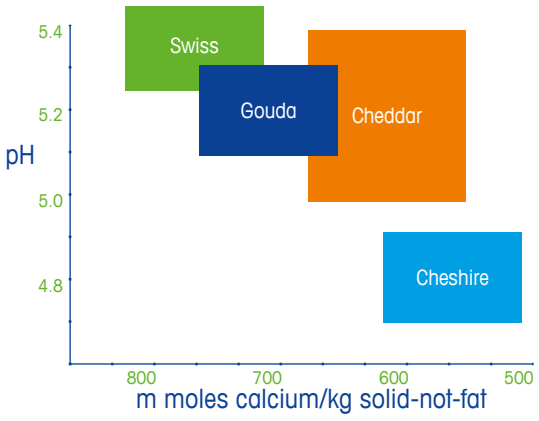

Figure 1: Relation of pH and calcium content with the type of cheese (taken from Lawerence, et.al).

Cheddar cheese tradionally has a wide range of pH and is easy to prepare when compared to Gouda and Chesire cheeses. The protein matrix of cheese is determined by the pH too. For example, a lower pH combined with a low calcium content makes the cheese crumbly, like in Cheshire, due to weak internal protein matrix. The Swiss cheese used in the study had a relatively high pH and mineral content with a strong protein matrix and hence had an elastic texture. Additionally, cheeses with a pH of 5.0 to 5.4 produce a gooey texture when heated. Cheeses with higher pH, however, burn when the same heat is applied. The pH value of the cheese also helps in defining storage conditions necessary from a food safety perspective.

Measurement Challenges

The efficacy and accuracy of pH measurement depends on two factors: interaction between the electrode sensing glass and the sample, and proper mixing of the reference electrolyte 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 of cheese samples when using a typical pH sensor.

Sample Challenge	Sample Impact
Solid sample material with tough consistency	Insertion into the sample is difficult with standard shaped glass membrane which can damage the sensor.
High protein sample content	Sensor junction damage due to clogging and precipitation causes inaccurate results.
High fat sample content	1. Insufficient miscibility of aqueous reference electrolyte with sample, which results in high response time. 2. Sensor fouling due to deposition on the glass membrane, which is difficult to clean and causes sluggish response.

Cheese samples, due to their tough consistency, require special provision for the sensor to facilitate its piercing into the sample. This is to ensure sufficient sample interaction with the membrane to initiate a signal. Delicate sensing membranes with spherical shapes can be broken during the measurement process.

Additionally, in the case of a conventional pH sensor with refillable electrolyte, high fat content in cheese samples makes it difficult for the outflowing aqueous electrolyte solution to mix readily with the sample components and attain a stable signal. Also, high fat and protein content accumulates on the sensor's glass, thereby preventing the sample from interacting with the membrane which leads to high response time

and inaccurate results. Further, when proteins from the sample interact with reference electrolyte, the proteins can precipitate. Such precipitation clogs a typical ceramic fritted junction, preventing electrolyte from further mixing with the sample and thereby causing measurement error.

Figure 2: Sample impact on a conventional pH sensor having a ceramic junction

InLab Solids Pro-ISM for reliable pH

The InLab Solids Pro-ISM (51344155) is a specialist sensor for measuring the pH of cheese 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.

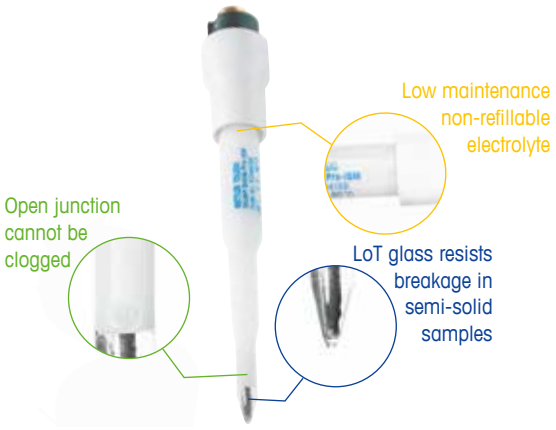

Figure 3: InLab Solids Pro-ISM pH sensor

The pH sensing membrane of this sensor is constructed from low temperature (LoT) glass, which has a low resistance and yields fast results. The sensor has a spear shaped tip made of toughened glass that allows direct insertion into the solid cheese samples and is resistant to breakage. The low maintenance solid XEROLYT®EXTRA polymer reference system offers two benefits: it has a clog-free open junction which eliminates the risk of protein fouling; and the sensor interacts with the sample through diffusing ions, eliminating the difficulties associated with immiscibility of aqueous reference electrolyte with the sample. The specialized design and overall sensor technology of the InLab Solids Pro-ISM ensures direct sample measurement of solid cheese samples. This is critical for ensuring reliability and consistency in the manufacturing and quality control of cheese.

Procedure and Method

Calibrate the sensor using buffers that bracket the sample range. Perform a two-point calibration of the electrode by using pH 4.01 and 7.00 buffer solutions. 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 by inserting the electrode tip into the sample. Repeat the measurement at various positions to obtain a representative pH reading. Alternatively, the cheese sample block can be grated for measurement; the pH sensitive membrane is immersed in the sample such that it is pressed against the sample mass. A standard deviation within ± 0.05 pH units indicates fair variance in the pH measurement of the sample. The sensor performance may become sluggish during the course of pH measurements due to contamination of the electrode surface. Proper care and handling of the sensor helps to maintain the optimum response time during the pH analysis.

Figure 4: InLab Solids Pro-ISM sensor to measure the pH of cheese

Results

Typical pH measurement results (performed in triplicates) for different cheese types, using the InLab Solids Pro-ISM Sensor.

Sample	Mean pH Value	Std.Dev.	Avg. time (s)
Processed Cheddar	5.572	0.011	37
Emmentaler	5.603	0.009	45
Gruyere	5.545	0.012	25
Caprice des Dieux	7.248	0.054	45

Expert Tips

- For thorough cleaning of the sticky residues from the electrode surface after the sample measurement, clean it with Ethanol or acetone and then rinse with de-ionized water.
- Regular maintenance is very important for prolonging the lifetime of pH electrode. Reconditioning schedule of electrode in 0.01 M HCl is recommended.
- Soaking the sensor in pepsin/HCl solution (51350100) for one hour once a week helps to remove protein build up on the glass membrane.
- The pH range for this sensor is 1 to 11 pH units and hence should not be exposed to harsh acidic or alkaline chemicals.
- 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.
- Never store the electrode dry or in distilled water, as this will affect the pH-sensitive glass membrane and thus shorten the lifetime of the electrode.

Further Information

- Electrode handling movies on:

YouTube

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

References

- Lawrence, R.C., Heap, H.A. and Gilles, J., 1984. A Controlled Approach to Cheese Technology1. Journal of Dairy Science, 67(8),pp.1632-164.
- Fox, P.F., 1989. Proteolysis During Cheese Manufacture and Ripening. Journal of Dairy science, 72(6), pp.1379-1400.

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

Document Number 30553147
Global MarCom 2670 PB/AG

www.mt.com/pH
For more information