Solutions to pH and acidity challenges in the food industry

pH and Acidity in Food

One of the most common measurements of food products is pH. The pH influences many qualities of food products including flavour, fermentations, texture, appearance and shelf stability. In food processing, some products require the measurement of pH to meet industry regulations to ensure the quality and safety of goods. A lower pH will help in preventing unwanted bacteria from growing thus extending the shelf life of a product. While food safety is a crucial consideration, understanding the pH of a food product can also help to achieve consistent flavours and textures. Through fermentation and other biological processes, many foodstuffs only achieve their desired qualities at particular pH values or ranges. pH is an essential parameter that requires close observation throughout food production to provide the best possible product.

It is very important to make a distinction between pH and acidity. Acidity refers to titratable acidity (TA), or the *concentration of acid* in a solution, while pH refers to the *strength of the acid* present. TA is more useful as a predictor of how an acid will impact the flavour of a food product. An example of this relationship is vinegar. Distilled white vinegar usually measures around pH 2.4 with a concentration of 5% acetic acid being the predominant acid. However, a sample of vinegar could be 8%, showing an increase in the concentration of acetic acid, but the measured pH value is still pH 2.4.

Food products can provide a number of challenges for the person that needs to measure pH or acidity. The products tend to be solid, semi-solid or as a slurry with a high content of solids, and each type of food demands a specific approach to measuring these parameters.

Let's consider some of the common food applications where measuring pH and acidity is essential: bread, cheese and yoghurt. From this brochure you will learn which problems may arise in testing acidity and pH during production in these industries, and how to avoid them.

Bread

For the bakery that produces processed bread which is sold in a store, it is important to add preservatives that extend the shelf life of the product. The preservatives are used to inhibit the growth of mould and bacteria. By extending the shelf life, the bakery is able to sell more product and thus increase their profitability. Adding preservatives is important due to the effect that they have in lowering pH. It is critical to measure the pH of dough to ensure that it is low enough to inhibit the bacterial growth. Common preservatives added to dough include benzoic acid, tartaric acid and calcium propionate.

Measuring acidity is very important for sourdough bread, known as the first type of bread to use a leavening agent. This leavening agent was hence referred to as "sourdough starter." This starter is a pre-ferment of flour which naturally contains bacteria in addition to yeast and water. The sugars which cannot be metabolised by yeast are instead fermented by the bacteria present. This process produces lactic acid, which is responsible for the slightly sour taste that is characteristic of sourdough bread. In order to produce a stable starter culture, the pH and total titratable acidity are closely monitored.

There are many ways to measure the pH of dough. A simple way is to make slurry with a portion of dough and deionized water. A way not to do it is to simply stick the meter into the dough. See the picture on the right of a pH electrode plugged up with dough. This creates many problems, including clogging the junction of the electrode and creating a challenge to cleaning the dough from around the glass electrode.

For the direct pH measurement in dough before baking, Hanna Instruments recommends the FC202X electrode or FC2022 Halo wireless pH probe with built-in temperature sensor. The probe has a spear tip electrode for easy penetration into the dough and is completely exposed for easy cleaning. The electrode also utilises an open junction design with a viscolene based electrolyte. The open junction design is virtually impossible to clog since any deposits can be easily removed, exposing the reference

cell. Lastly, the PVDF body is a food grade plastic that conforms to specifications and requirements for the food processing industry. It has high abrasion resistance, mechanical strength and resistance to ultraviolet and nuclear radiation, as well as resistant to fungal growth.

To measure TA during bread production, many bakeries use manual titration to determine their endpoint, but over-titration is a common error encountered with this method. With automatic titration, the endpoint is precisely determined due to a much smaller minimum dose size than they are achieving in their manual titrations. To determine TA in bread, Hanna Instruments recommends the HI902C automatic titration system. As dough sample can be very thick, deionised or distilled water is commonly added as part of the sample preparation. The HI902C methods can be optimized for things such as a pre-titration stir time, ensuring a more fluid, homogeneous mixture. The HI902C can also measure pH with the open junction FC210B pH preventing any clogging issues from the viscous dough mixture.

Cheese

Throughout the cheese making process, pH control is critical to ensure consistent fermentation and food safety. If the pH is too low, the cheese may be prone to a brittle or pasty texture, as well as growth of mould after packaging. If the pH is too high, the cheese may become too firm, and can potentially be dangerous for consumption due to the risk of pathogen formation. The pH must be carefully monitored to detect deviations from the optimal range, which can create problems with texture, taste and public safety of cheese.

The starting quality of the raw milk and cream being used for cheese making also has significant impacts on the quality of the final product. Fresh milk should have a pH of 6.5–6.7 and a titratable acidity of 0.10–0.25% lactic acid. Values outside of this range can indicate potential cow illness or microbial spoilage from contamination or improper storage.

Cheese products can provide a number of challenges for the person that needs to measure pH because they tend to be solid to semi-solids. Both types of samples will coat the sensitive glass membrane surface and/or clog the reference junction of the standard pH electrode.

This is why Hanna instruments created the FC242X cheese specific electrode that is supplied with the HI98165 pH meter. This specialised electrode offers numerous features that improve pH testing for cheese producers. The robust stainless steel sheath paired with the conical sensing tip allows for penetration in cheese at various points throughout the production process. An integrated temperature sensor also ensures that all pH measurements are compensated for temperature without the need for a separate temperature probe.

Apart from pH, cheese and yoghurt manufacturers need to measure acidity of their initial milk and final products. When purchasing raw, unpasteurized milk for cheese making, the initial milk quality is especially important. Many companies are performing manual titrations for acidity using phenolphthalein as a colour indicator, but they are often unhappy with the repeatability and consistency of their results.

When working with milk and dairy products, detecting this colour change becomes very difficult. The milk sample below has been titrated to 8.3 (left) and unreacted (right).

This is the reason to move from a manual titration with a colour indicator to a pH endpoint of 8.3. Because pH 8.3 is the point that phenolphthalein changes from colourless to pale pink, a titration to pH 8.3 will comply with their standard method while removing the subjectivity of a colour indicator endpoint. For measuring titratable acidity (TA) in dairy products, Hanna Instruments offers the HI902C Potentiometric Titrator. This acid/base titration is performed using NaOH titrant to an endpoint of pH 8.3 and results are expressed as g/100ml of lactic acid.

Yoghurt

Monitoring pH is crucial in producing consistent, quality yoghurt. Yoghurt is made by the fermentation of milk with live bacterial cultures. Most yoghurts are inoculated with a starter culture consisting of Lactobacillus bulgaricus and Streptococcus thermophilus. Once the live culture is added, the mixture of milk and bacteria is incubated, allowing for fermentation of lactose to lactic acid. The pH of the mixture drops and becomes more acidic due to the lactic acid production; this reduction in pH causes the casein protein in milk to coagulate and precipitate, resulting in a yogurt-like texture.

By checking the pH during yoghurt production, manufacturers can ensure that fermentation was consistently stopped at the correct pH value for every batch. For measuring pH in yoghurt, Hanna Instruments created the HI98164 meter supplied with the FC213 probe The FC2133 amplified pH electrode is a specialised probe that offers numerous features that improve pH testing for yogurt producers. Clogging of the reference junction is a common challenge faced by yogurt producers as the milk solids and proteins can easily build up on the electrode. The open junction design of the FC2133 utilises a viscolene reference electrolyte that comes into direct contact with the yogurt sample. Without a physical junction, the electrode resists clogging and continues to provide accurate, stable readings.

Acidity measurement during yoghurt production can be performed by automatic titration as described above in cheese analysis section. With the help of a Hanna Australia national titration specialist and the features of the HI902C titration system, any customer is able to bring acidity analysis into their QA lab.

Products mentioned:

FC2022 HALO PVDF Body pH Electrode with Bluetooth® - revolutionary pH electrode that incorporates wireless technology with an application specific design. This electrode has many features that makes it ideal for measuring food related products. These features include: low temperature (LT) glass, conical bulb, food grade PVDF body, and open junction with viscolene gel electrolyte. The FC2022 is compatible Apple or Android device running the free Hanna Lab App.

HI98161 Waterproof pH Meter for Food Analysis – rugged, waterproof, portable pH meter that measures pH and temperature using the specialised FC2023 Foodcare pH electrode. The HI98161 is supplied with all necessary accessories to perform a pH/temperature measurement packaged into a durable thermoformed carrying case that holds the meters, probes and calibration buffers securely in place.

HI98164 Professional Portable Yogurt pH Meter – rugged, waterproof, Foodcare portable pH meter that measures pH and temperature using the specialised FC2133 yogurt pH electrode. Supplied in a hard carrying case with all necessary accessories (beakers, calibration/cleaning solutions, USB cable and PC software).

HI98165 Professional Portable Cheese pH Meter – rugged, waterproof, portable Foodcare pH meter that measures pH and temperature using the specialised FC2423 cheese pH electrode. Supplied in a hard carrying case with all necessary accessories (beakers, calibration/cleaning solutions, USB cable and PC software).

HI902C Automatic Potentiometric Titration System – automatic titrator dedicated to efficient and accurate laboratory analysis. The HI902C can perform acid/base, redox (ORP), complexometric, precipitation, non-aqueous, argentometric, and ion selective titrations, as well as back titrations and titre determinations. This powerful titrator automatically dispenses the titrant, detects the endpoint, and performs all necessary calculations and graphing. In addition to titration, the HI902C also operates as a fully functional pH, mV/ORP, and ion selective electrode (ISE) meter.

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