pH Application Note

pH Measurement of Fruit Juice

InLab Max Pro-ISM Sensor

The acidic nature of fruit juices makes pH determination a norm for juice manufacturing industries. Accurate and reliable pH measurement is required to maintain quality and batch consistency. The particulate nature of the fruit juice sample can easily clog a conventional pH sensor which has a ceramic junction. Precision with repetitive measurements becomes difficult if the pH sensor cannot be cleaned properly and the interaction of the delicate pH sensing membrane with the sample is blocked. The state of the art design of METTLER TOLEDO's InLab Max Pro-ISM, is not only user friendly and hassle free, but also offers the most accurate and precise pH results for such samples.

METTLER TOLEDO

Introduction

Fruit juices are nutrient-rich beverages and are among the most popular food preferences of health conscious consumers. The tremendous increase in demand for fruit juice is compelling manufacturers to develop new variants and adopt better manufacturing processes. US FDA recommends HACCP (Hazards Analysis and Critical Control Point) for production of all juices where "juice" is defined as an aqueous liquid expressed or extracted from one or more fruits or vegetables, purees of edible portions of one or more fruits or vegetables, or any concentrates of such liquid or puree. Any juice sold as such or used as an ingredient in another beverage needs to be processed with the requirement listed in 21 CFR part 120.

Juice is a natural product which means it is susceptible to deterioration due to both chemical activity (enzyme action) and bacterial spoilage. Preservation is an important step in the manufacturing of juice. One of the methods for preservation and processing of fruit juices is pasteurization. High-temperature, short-time (HTST) pasteurization is preferred for perishable beverages as it prevents microbial growth and maintains freshness, color and better flavor. pH plays an important role in managing the parameters of these preservation techniques.

Importance of pH Measurement

Among several intrinsic factors that affect the shelf life and spoilage-rate of juice, pH and water activity are the most influential. Variations of pH can influence flavor, consistency, and shelf life. Fruit juices usually have low pH values that range between 2.0 and 4.5. The low pH of fruit juices is due to the presence of organic acids that varies with the different type of juices.

In raw juice processes, a 5-log reduction of the most resistant pathogenic microorganism is required by the FDA regulation. The thermal processing steps required for this practice depends on the initial pH values of the raw juice.

Measurement Challenges

The particulate nature of the fruit juice can pose sample challenges for pH measurement. The typical ceramic fritted junction can get clogged easily by the dispersed particulate sample nature. This can further restrict the interaction of the sample with the reference electrolyte and can affect the overall efficacy and accuracy of pH measurement.

The table below outlines the challenges and negative effects on pH measurement results when a typical sensor is used for juice samples.

Sample Challenge	Sample Impact
Particulate sample nature	The ceramic junction of the pH sensor can get clogged easily.
Outflow of reference electrolyte	Interaction of sample with the reference electrolyte can be hampered if the flow is obstructed due to clogging. Results in sluggish and unstable pH values.
Cleaning of sensor after measurement	Sensor fouling due to deposition on the delicate glass membrane, which is difficult to clean. Robust and easy to clean pH sensor required for prompt pH analysis.

A steady outflow of reference electrolyte is necessary to achieve accurate and precise results. A clogged junction can restrict this flow and hamper the interaction of the sample with the reference electrolyte. Delicate sensing membranes can be damaged while being used in concentrate solutions that have high density of suspended solid particles from fruits. For this reason, some labs turn to indirect measurement techniques, wherein the sample is blended with water prior to measurement. However, this blending process affects the pH measurement results, yielding inaccuracies and time inefficiencies.

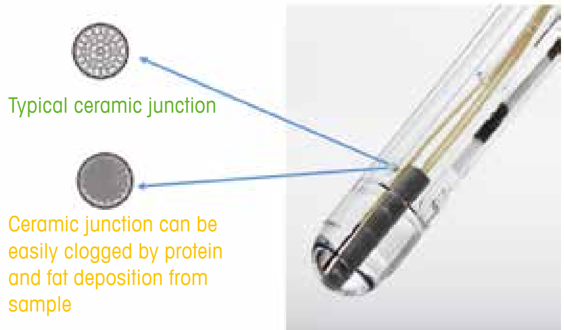

Figure 1: Sample impact on a conventional pH sensor having a ceramic junction

Repetitive pH measurements can foul the sensor membrane due to accumulation of various contaminants and are difficult to be wash off. The user may experience unstable and erroneous results if the sensor is not cleaned adequately for the next measurement.

Perfect sensor for all juice samples

For the pH measurement in the intermittent stages as well as of the final product, we recommend the InLab Max Pro-ISM Sensor (30248830). The sensor has an immovable glass sleeve junction that helps measurement in samples that contain dispersed particulate substances, allowing for faster measurement. The sleeve junction maintains a steady flow of electrolyte even in dense suspension of juice sample and prevents the contaminants from entering the reference system or clogging the junction. The sensor thus possess a self cleaning ability.

This sensor has HA type glass membrane (high alkali glass) which makes the sensor robust. Measurement at high pH values with minimized interference of alkali errors is possible due to this glass membrane. The sensor has a built-in temperature probe and provides Intelligent Sensor Management (ISM) technology, allowing users to accurately capture all critical measurement parameters. The specialized design and overall sensor technology of the InLab Max Pro-ISM ensures direct sample measurement of fruit juice, without the need for undue dilution of the sample with water. It enables reliable pH monitoring for a consistent batch production.

Figure 2: InLab Max Pro-ISM pH sensor.

InLab Expert Pro-ISM pH sensor (30014096) can be alternatively used for this sample application. The open junction avoids clogging and makes it easy to clean. The solid XEROLYT®EXTRA polymer reference system eliminates the need for refilling of electrolyte. The PEEK shaft body of this pH sensor makes it robust and user friendly in both lab and outdoor application. Overall design of this low maintenance sensor can be used to measure pH in fruit juice with ease.

Procedure and Method

Calibrate the sensor using buffers that bracket the sample range (in this case, MT pH buffers of 2.00, 4.01 and 7.00 are used).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 measurements.

Figure 3: InLab Max Pro-ISM sensor to measure the pH of fruit juice.

Immerse the pH sensor in the fruit juice such that the sensor membrane and junctions are in contact with ample amount of sample. Repeat the measurement in triplicates to monitor the variance if any. A standard deviation within ±0.05 pH units indicates a fair variance in pH measurement of the sample.

Results and Discussion

Samples of various fruit juices were analysed for pH at room temperature. Average pH values for the samples (performed in triplicates) using InLab Max Pro-ISM pH sensor are given in below Table.

Juice Sample	Mean pH Value	Std. Dev.	Avg. Time (s)
Clear Apple Juice	2.96	0.01	35
Clear Cranberry Juice	2.52	0.02	41
Orange Juice	3.69	0.01	19
Lychee Juice	3.68	0.01	23
Pineapple Juice	3.56	0.01	35
Fresh lemon juice	2.23	0.04	22

Expert Tips

- After every measurement, thoroughly clean the pH sensor using deionized water.
- Clean the electrode after every pH measurement. Contaminated electrode surface leads to slow response of the sensor.
- For thorough cleaning of the residues from the electrode surface after the sample measurement, cleanse it with mild soapy solution, and later rinse it with de-ionized water.
- Do not rub the sensor surface; always dab off the excess water using tissue paper.
- In between measurements or when the electrode is not being used for a brief period, it is best to keep it in wetting cap filled with InLab Storage Solution (30111142).
- Periodic reconditioning of the electrode in 0.1M 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. An old sensor may need frequent conditioning, compared to a new sensor. Remember to re-calibrate the sensor after reconditioning.
- Never store the electrode dry or in distilled water, as this affects the pH-sensitive glass membrane shortening the lifetime of the electrode.
- Ensure use of correct buffers in the correct sequence. Always use fresh buffers. Check expiry date

Further Information

- Electrode handling movies on:

  YouTube

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

References

- Juice HACCP Rule (Code of Federal Regulations) 21 CFR part 120.
- Nelson, P.E. and Tressler, D.K., 1980. Fruit and vegetable juice processing technology. AVI Pub. Co.
- Code of Federal Regulations. 21, Chapter 1 (4-1-12 ed.), part 146—Canned fruit juices. U.S. Printing Office, Washington, D.C.

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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