pH Application Note

pH Measurement of Wine

InLab Max Pro-ISM Sensor

Wine is an alcoholic drink made from fermented grapes. It comes in a variety of flavors and colors, ranging from very sweet to dry and tart. These unique characteristics of wine are in part due to its acidic nature. Because of this, pH is the second most important parameter in the wine making process, following sugar content (brix). Accurate and reliable pH measurement is required to maintain the characteristic texture and flavor of wine. A conventional pH sensor with a ceramic junction can get clogged easily due to the particulate nature of the sample, especially during the initial fermentation stage. Repetitive measurements become challenging if the pH sensor is difficult to clean. The state of the art design of METTLER TOLEDO's InLab Max Pro-ISM, is not only user friendly and hassle free, but also provides the most accurate and precise pH results for every stage of wine making process, alleviating the challenges discussed above.

METTLER TOLEDO

Introduction

Wine pairs well with food and celebration. Raising a glass of champagne, the ultimate sparkling wine, gives the right boost for a perfect celebration. Be it a red wine or a white wine, every type owes its famed great flavor and taste to proper processing from harvest to bottling. pH plays an important role in wine making because its correlated to the acid content present during the fermentation process, contributiong to the flavor and shelf life of the product.

Figure 1: Vineyard in Brazil area.

The wine-making process primarily relies on the fermentation of grapes wherein the yeast consumes the fruit sugar and converts it to ethanol. The alcoholic fermentation results in the formation of organic acids such as malic acid, tartaric acid and citric acid. Apart from these acids, there are other organic acids present in wine, partly originating from the bacterial involvement in the process. The wine making process for a red wine diverges from that of a white wine during the initial ferment stage. For a red wine, pulp of red or black grapes ferments together with the grape skins, creating the typical red color. The white wine is made by fermentation of just the grapefruit juice extract, without the skins. The pH value contributes to the physicochemical and biological properties to develop individual aroma, texture and flavor of the final product.

Importance of pH Measurement

Wine makers mostly target to produce a wine with a pH value within 3.0 to 4.0 pH units. The desired quality and batch consistency depends on this predefined value. pH monitoring helps in determining the ripeness of the grape, color stability of must and wine along with the microbial and chemical stability. The pH prevents spoilage by inhibiting the microbial growth, increasing the effectiveness of sulphur dioxide to protect the wine and also increasing the efficiency of bacteria in converting malic acid to lactic acid. The protein stability and sensory attributes of wine are also dependent on the pH value. For a wine to be marketed with a pH value outside the specified limits, it needs to be carefully evaluated against the risk of spoilage.

Measurement Challenges

The particulate nature of the sample during the winemaking process can pose sample challenges for pH measurement. For example, a typical ceramic fritted junction can get clogged easily due to the nature of the sample. This can further restrict the interaction of the sample with the reference electrolyte and can affect the overall efficacy and accuracy of the pH measurement.

The table below outlines the challenges and negative effects on pH measurement results when using a typical sensor for wine 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. This results in sluggish response 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 sample with the reference electrolyte. During the initial process, there is a high probability of suspended solid particles in the sample coming from grapes or other fruits, depending on the type of wine. Delicate sensing membranes of pH sensor can be damaged while being used in such sample solutions.

Repetitive pH measurements can foul the sensor membrane due to accumulation of various contaminants that are difficult to wash off properly. The user may experience unstable and erroneous results if the sensor is not cleaned adequately for the next measurement. pH adjustment in the winemaking process is achieved by either addition of acids (chemical means) or by blending it with a finished wine having required acid levels. This process may need a wide range of pH monitoring and thus requires a robust sensor suitable for such application.

Accurate pH for Great Taste

InLab Max Pro-ISM (30248830) is a specialist sensor for measuring the pH of wine with accuracy and precision. The sensor has an immovable glass

sleeve-junction that ensures steady outflow of the electrolyte. From the initial winemaking step of fermentation, including analysis of "must", to the analysis of the finished product, the sensor can be used to record an accurate and faster pH value. The samples containing dispersed particulate substances do not hinder the smooth functioning of this pH sensor. Thanks to the sleeve junction that maintains a steady flow of electrolyte, even in dense suspension of sample solution. This characteristic prevents the contaminants from entering and clogging the junction and allows this sensor to be self-cleaning and low maintenance.

The sensor features enable accurate pH monitoring for a consistent batch production of wine. The pH membrane is made of HA type glass (high alkali glass) which makes the sensor robust and suitable for such samples. The sensor has Intelligent Sensor Management (ISM) technology that offers data security, stores calibration history and monitors maximum temperature exposure of the sensor. "Pro" stands for a built-in temperature probe in sensor that helps to capture the sample temperature accurately and supports the ATC (automatic temperature compensation) functionality. pH measurements are highly temperature dependent. For an accurate pH value, the pH calibration slope needs to be corrected to measurement temperature. By the virtue of ATC, this is attained so as to take care of the influence of temperature dependence on the sensor and pH system. For example, while measuring a sample at 15 °C, the right temperature ensures the calibration slope is corrected to represent the system performance at 15 °C. However, effect of temperature on the ionic activity of the sample cannot be calculated by a mathematical formula and needs to be determined by measurement at that temperature. Hence, in a given case, the pH value measured at 15 °C would differ from the pH value at 35 °C.

Figure 2: InLab Max Pro-ISM pH sensor.

InLab Expert Pro-ISM pH sensor (30014096) can be alternatively used for this 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 or any outdoor application. Overall design of this low maintenance sensor, enables a quick and reliable pH measurement in wine.

Procedure and Method

Calibrate the sensor using buffers that bracket the sample range (in this case pH 2.00, 4.01 and 7.0). 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: Measuring a wine sample using InLab Max Pro-ISM sensor.

Measure the pH of the wine sample at ambient temperature. Perform the measurements in triplicates to obtain a representative pH reading. A standard deviation within ±0.05 pH units indicates fair variance in pH measurement of the sample.

Results and Discussion

The pH value of different wine samples were recorded using sensors InLab Max Pro-ISM. All the wine samples were measured in triplicates and the standard deviation and average response time were noted as enlisted in the below table.

Sample	Mean pH Value	Std. Dev.	Avg. Time (s)
Chardonnay	3.286	0.01	21
Cabernet Shiraz	3.844	0.01	30
Riesling	3.262	0.01	20
Chenin Blanc	3.493	0.02	10
Merlot	3.589	0.01	24

Expert Tips

- After every measurement, thoroughly clean the pH sensor using deionized water. Use mild soapy water if required. In that case, rinse off again using deionized water.
- Limiting the temperature dependence to the minimum can ensure most accurate pH results. For example, Maintaining calibration buffers, sample and sensor at a same temperature facilitates accuracy in pH measurement.
- 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).
- Never store the electrode dry or in distilled water, as this affects the pH-sensitive glass membrane shortening the lifetime of the electrode.
- 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. More frequent conditioning is needed for an old sensor compared to a newer sensor. Remember to recalibrate the sensor after reconditioning.
- Ensure use of correct buffers in the correct sequence. Always use fresh buffers. Check expiry date. Select the right buffer group in the meter.

Further Information

- Electrode handling movies on:

YouTube

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

References

- Boulton, R., 1980. The relationships between total acidity, titratable acidity and pH in wine. American journal of enology and viticulture, 31(1), pp. 76–80.
- AOAC Official Method 960.19, pH of Wines. 16th edition. 1999.
- Davis, C.R., Wibowo, D.J., Lee, T.H. and Fleet, G.H., 1986. Growth and metabolism of lactic acid bacteria during and after malolactic fermentation of wines at different pH. Applied and environmental microbiology, 51(3), pp. 539–545.

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