

pH Measurement of Beer

InLab Versatile Pro Sensor

Accurate and reliable pH measurement of beer is required to maintain the characteristic texture, flavor, color of every beer type and its shelf stability. InLab Versatile Pro is a flexible sensor with a replaceable junction suited for this application. It's an accurate yet economic pH sensor for routine measurements of the beer industry. METTLER TOLEDO's pH sensor, is not only user friendly and hassle free, but also provides rapid and precise pH results for beer samples.



Introduction

The production of beer has undergone substantial advancements throughout its evolution from traditional brewing methods to industrial production. After water and tea, beer is the most consumed beverage in the world. Today, majority of beers are brewed from malted barley, though other cereal grains such as wheat, rye, corn, and rice are also used. The two key families of beer can be divided into ales and lagers. Ales have the typical fruity flavor while lagers are normally golden, clear, carbonated brew and are best sellers worldwide. More than color or flavor, the fundamental distinguishing factors between these two are the types of yeast. Owing to this difference in their yeast types, ales are top fermented whereas lagers are bottom fermented.

Importance of pH Measurement

Beer production involves various steps such as mashing, mashing, boiling, fermentation, maturation, filtration, carbonation, and cellaring, resulting in a complex biochemical process. Each of these steps, influence the taste, flavor, profile, and alcohol content of the beer.

Enzymatic and yeast activity during the mashing and fermentation process depends on pH. For optimal enzymatic conversion of starch to fermentable sugars, the pH of the mash (a mixture of milled grain like barley and water) should remain between 5 to 5.6 pH. During sparging and the runoff of wort into boil kettle, it is important to maintain a pH below 5.8. Above this threshold, polyphenols may be extracted resulting in astringency and instability of the final product. pH analysis of wort (sugary liquid left after enzymatic reaction of malt) is also significant. Lower pH of finished wort ensures better yeast activity during fermentation. The pH of finished beer should generally be lower than 4.5 to inhibit spoiling bacteria. Solubility of hops that are used as flavoring and stability agent in beer are pH dependent as well. pH influences flavor and clarity in an aging beer. Optimal pH catalyzes protein coagulation during boil and is pivotal for clarity. Hence, pH plays a substantial role during various stages of beer manufacturing including the finished beer.

Measurement Challenges

Beer production involves frequent pH measurement during different stages, beginning with process water all the way through finished beer. A tough pH sensor is required for robust handling. Sensitive and fast response of the pH sensor is needed for a reliable and quick analysis. Inaccurate results lead to inconsistencies in quality, yield quantity and taste. This can disturb the overall productivity and efficiency of the finished batch.

The table below outlines the challenges and impact on pH measurement results during the analysis of beer samples.

Sample Challenge	Sample Impact
Reading fluctuations	Inaccurate results
Sluggish response	Interaction of sample with the reference electrolyte can be hampered if the junction is clogged. This results in a sluggish response and unstable pH values
Outdoor or at-line measurements	Requires sensor that gives reliable results, yet economical and easy to handle
pH at different temperature	Integrated temperature probe is required for right temperature compensation and to avoid inaccurate results

Accurate pH for a Perfect Beer

For the pH measurement of the finished beer, we recommend the InLab Versatile Pro pH sensor (51343031). This sensor is an economical choice for routine measurements in beer samples, yet accurate. The body of this sensor is made of polysulfone and hence robust to handle. It has a ceramic junction which can be replaced when required. A special replacement junction tool (51340267) is available for changing the ceramic diaphragm. It is a specially designed sensor for robust and fast pH measurements at different workplaces, which includes laboratory, at-line and outdoor environments. The sensor is available in variety of kits with the bench top meter (30130865, 30019032) and also available with the portable meter, S2- Light (30207953).

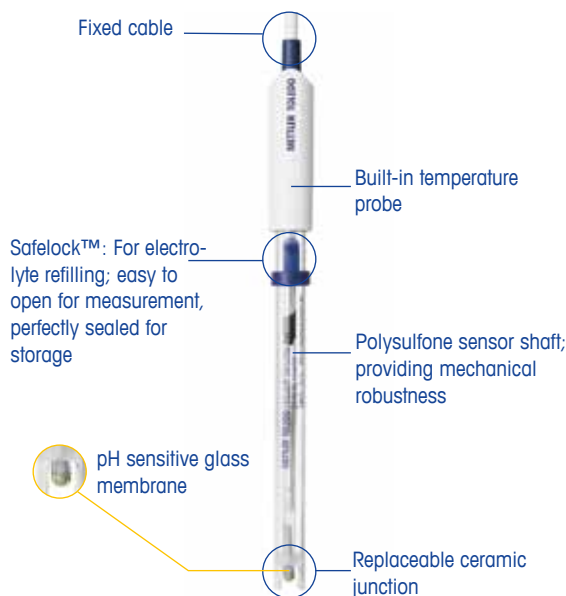


Figure 1 : InLab Versatile Pro pH sensor

The sensor has an integrated temperature probe with a fixed cable. 'Pro' stands for a built-in temperature probe in the sensor that helps to capture the temperature accurately and supports the ATC (automatic temperature compensation) functionality. All MT pH meters have ATC function. pH measurements are highly temperature dependent. For an accurate pH value, the pH calibration slope needs to be corrected to the measurement temperature. By the virtue of ATC, this is attained and thus the influence of temperature dependence on the sensor and pH system is taken care. 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. Since pH value of the samples change with temperature, it is important to compare only pH values measured at the same temperature.

For pH measurement of samples with high particulate nature such as in the mash or in finished beer subject to adjunct treatments, clogging of ceramic junction is possible. In such cases, InLab Max Pro-ISM (30248830) is recommended. The electrode has an immovable glass sleeve-junction that ensures steady outflow of the electrolyte. The samples containing dispersed particulate substances do not hinder the smooth functioning of this pH sensor. The sensor has a glass body with a built-in temperature probe and ISM (Intelligent Sensor Management) features.

Procedure and Method

Calibrate the sensor using buffers that bracket the sample range. 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. that allows for calibration at the measured temperature of the pH buffer. 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 in compliance with USP <791>.



Figure 2: Measurement of beer sample using InLab Versatile Pro pH sensor

Perform measurements of the samples at the required temperature in triplicate. A standard deviation within ± 0.05 pH units indicates a fair variance. Rinse the electrode with deionized water after each measurement.

Results and Discussion

The pH values of different style beer samples were measured in triplicate using InLab Versatile Pro pH sensor. A standard deviation of less than ± 0.05 and average response time of less than 20 seconds were observed for this beer samples.

Beer Sample	Mean pH Value	Std.Dev.	Avg. time
Lager sample 1	4.21	0.03	18 sec
Lager sample 2	3.97	0.01	08 sec
Ale Sample 1	3.97	0.01	18 sec

Table: pH values of beer samples measured with InLab Versatile Pro.

Expert Tips

- After every measurement, thoroughly clean the pH sensor using deionized water. Use mild soapy water if required. After cleaning, always, rinse off again using deionized water. Cleaning the sensor with ethanol is an alternate option, provided the sensor is rehydrated well after cleaning.
- Alcohol exposure dehydrates the sensor membrane. Hence, try to limit this time to minimum. In case of such exposure, remember to rehydrate the membrane by rinsing it with water and then soaking it in storage solution for 5 minutes before next use.
- In between measurements or when the electrode is not being used for a brief period, it is best to keep it in the wetting cap filled with the 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. The frequency of reconditioning would depend upon the number of samples analyzed per day and the life of the sensor. Old sensors require frequent conditioning compared to new sensors. Remember to re-calibrate the sensor after reconditioning.
- Make sure to open SafeLock™ (electrolyte filling hole) during pH calibration and measurement. Remember to re-calibrate the sensor after refilling of the electrolyte.
- Maintaining calibration buffers, samples and sensors at the same temperature facilitates accuracy in pH measurement. This would limit the temperature dependence to the minimum.
- Do not rub the sensor surface; always dab off the excess water using paper tissue.
- Ensure use of correct buffers in the correct sequence. Always use fresh buffers. Check the expiration date. Select the right buffer group in the meter.

Further Information

- Electrode handling movies on:



- Comprehensive range of pH meters, electrodes, solutions, and accessories:

► www.mt.com/pH

References

- Kaneda, H., Takashio, M., Tamaki, T. and Osawa, T., 1997. Influence of pH on flavour staling during beer storage. *Journal of the Institute of Brewing*, 103(1), pp.21-23.
- Guyot-Declerck, C., François, N., Ritter, C., Govaerts, B. and Collin, S., 2005. Influence of pH and ageing on beer organoleptic properties. A sensory analysis based on AEDA data. *Food quality and preference*, 16(2), pp.157-162.
- Vanderhaegen, B., Delvaux, F., Daenen, L., Verachtert, H. and Delvaux, F.R., 2007. Aging characteristics of different beer types. *Food chemistry*, 103(2), pp.404-412.
- Coote, N. and Kirsop, B.H., 1976. Factors responsible for the decrease in pH during beer fermentations. *Journal of the Institute of Brewing*, 82(3), pp.149-153.

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