ACIDIC, NEUTRAL OR ALKALINE?

Constant and reliable pH measuring in breweries

The brewing process is based on natural products whose characteristics and qualities change from season to season. To be able to ensure consistent quality and taste despite these changes, numerous individual process parameters need to be observed. An important parameter in this context is the pH value, which plays an essential role in several process stages when it comes to ensuring consistent quality.

Inline measurement points need to produce reliable results in spite of CIP processes, high temperatures and pressures, and increased flow rates. This is where conventional glass electrodes soon reach their limits. They are characterized by a number of disadvantages such as their fragility during CIP processes, the risk of glass breakage, short calibration intervals and drifting measurement values due to ageing of the glass probe.

CIP and periodic calibration processes make it necessary to remove the glass electrodes from the system, often associated with complex retractable assemblies and high maintenance efforts. The life cycle of a glass electrode is influenced by a great number of different factors, which means that the measurement point must be monitored and maintained constantly. Ageing is one the most important factors here, as it affects the probe's sensitivity and measurement characteristics. Conventional glass electrodes need to be calibrated and replaced at regular intervals in order to compensate for the effect of ageing.

Pfaudler pH probes made from robust, anti-adhesive glass-lined steel represent a solution when it comes to meeting high quality standards under challenging process conditions. Thanks to the combination of a robust steel body with a coating made from technical glass-lining, Pfaudler pH probes are capable of withstanding chemical, thermal and mechanical stresses.

This means that the pH probes can be installed directly in the piping and production tanks – making the use of expensive and complex retractable assemblies a thing of the past. When using conventional glass electrodes, care must

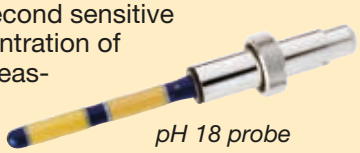
Good to know

Pfaudler pH probes are divided into two main categories according to their measurement principle: absolute and differential measurement technology.

In the case of Pfaudler probes with the absolute measurement principle (e.g. pH Reiner type), the reference liquid is introduced into the process by means of overpressure in order to establish a measuring circuit to the pH-sensitive glass lining. The reference electrode is installed in the pressurized electrolyte line and the connection to the product to be measured is estblished through a ceramic ground-joint diaphragm. The external electrolyte vessel is connected to the probe via hose coupling. This technology and the fact that the probe is only wetted with product on one side contribute to slowing down the ageing process. Regular calibration is not necessary, given that the measurement characteristics remain stable.

pH Reiner probe

Pfaudler differential probes (e.g. pH 18 type) consist of two ion-sensitive glass linings fused onto a probe carrier. One of the surfaces provides the product-specific reference potential depending on the salts dissolved in the liquid, while the second sensitive glass-lined surface measures the concentration of hydrogen ions in the medium. As this measurement method produces a product-specific reference value, it is only suitable for recurring or invariable processes. Both types of measurement electrodes are characterized by long-term stability and are therefore not subjected to ageing. After determining the slope by means of a reference measurement, the probe is ready for permanent operation. With this type of probe, potential defects such as in the diaphragm, the electrolyte line or the external reference electrode can be ruled out entirely.



pH 18 probe

be taken during the production process and following CIP procedures to ensure that the electrodes are always immersed in the liquid medium. If the electrodes were to dry out, they would become damaged and could no longer be used in the measuring device. Pfaudler pH probes, on the other hand, can be stored under dry conditions for an unlimited period of time, without any adverse effects on their measurement characteristics.

Application of pH probes in breweries

– Brewing water treatment
– Mashes
– Wort boiling
– CIP processes
– Filling
– Flushing water treatment
– Waste water treatment

Mashes

Brewing water treatment is the fundamental basis for subsequent steps of the brewing process and an important factor for the stability and taste of the beer. The water's pH value considerably influences how it reacts with the other ingredients. The effect and reaction of enzymes in the mashing process, for example, heavily depends on the brewing water's pH value. Another step of water treatment is to deaerate the water, which is done by removing the oxygen. The pH value must be kept at a stable level in this process in order to avoid variations in quality.

In the mashing process, malt grind is mixed with water and heated gradually to release the enzymes in the malt. The enzymes break down the starch in the malt to produce fermentable sugar, while the pH value of the water is reduced. The pH value needs to be measured continuously in order to be able to monitor and control this reaction. This way, additional dosages can be added and corrections made in a precise manner. For most beers, the optimum mash pH value ranges between 5.4 and 5.6 pH. When using ISFET probes, there is a risk of the sensitive surface becoming clogged due to solids contained in the mash, resulting in a failure of the measurement point. This kind of error can be ruled out with Pfaudler pH probes, thanks to their large and particularly smooth pH-sensitive glass-lined surface. To remove solids from the mash, it is pumped in the lauter tun and filtered.

Wort boiling

After lautering, the wort is pumped into the wort kettle and heated. Hops are added to the wort shortly before it reaches the boiling tem-

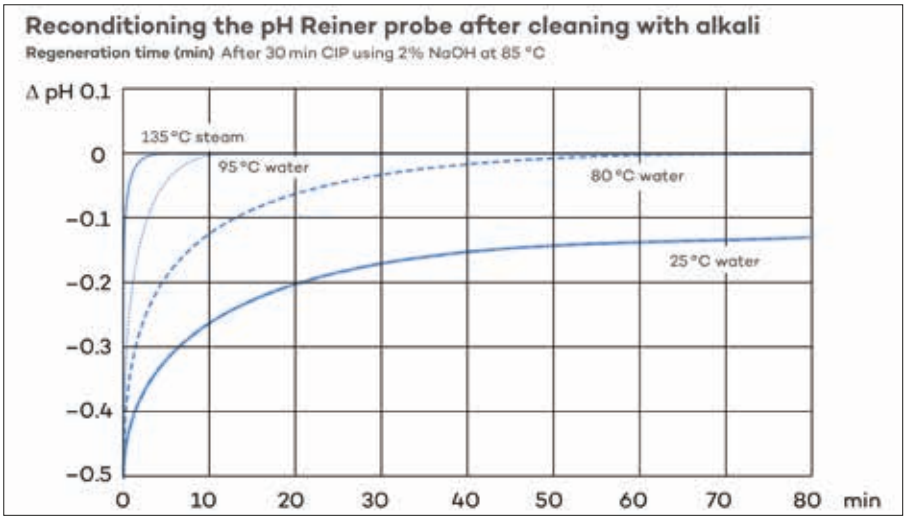


Fig. 1: Reconditioning the pH Reiner probe after cleaning with alkali

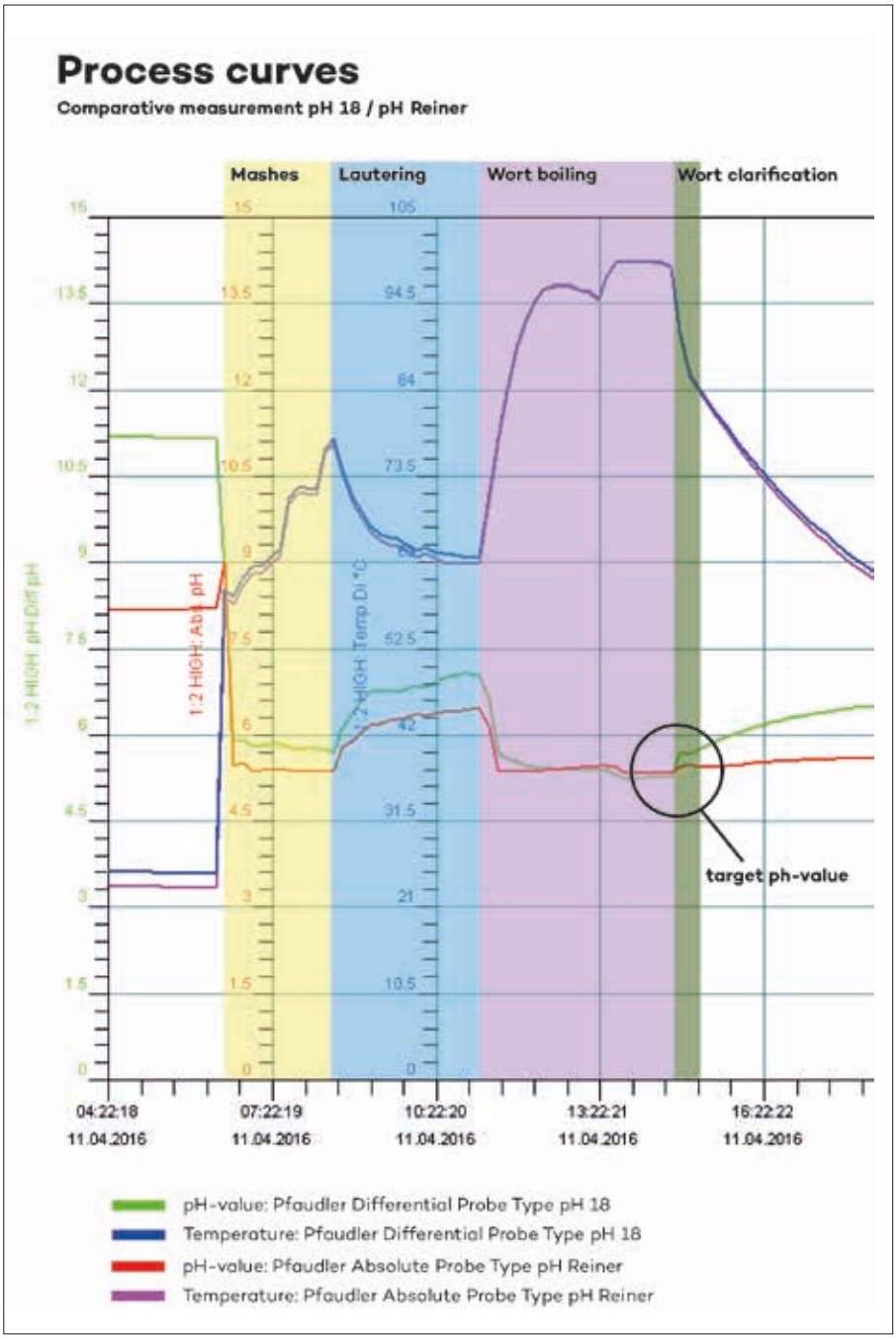


Fig. 2: Comparative measurement diagram in the mashing and wort process at Weldebräu using Pfaudler absolute and differential pH probes

perature to achieve the desired original wort. The beer's taste stability is ensured by adding lactic acid. The boiling process deactivates bacteria and enzymes in the malt, isomerizes hops, prevent evaporation of unwanted aromatics, precipitates proteins and tanning agents, and to precisely set the original wort concentration.

Accurate measurements are crucial in this step, as decreases in the pH value need to be monitored closely in order to ensure that the results can be reproduced at any time.

CIP process

Cleaning in place is a method of cleaning process plant components using water, bases, acids or hot steam to remove contaminants in an easy manner and without any residues. Cleaning agents are introduced into the process and heated to up to 90 °C. This makes it necessary to remove conventional pH glass probes and ISFET probes by means of retractable assemblies, as they would otherwise become damaged and would have to be replaced.

Since Pfaudler pH probes are capable of withstanding these challenging conditions, they can remain in the process and continue to produce reliable results after a short regeneration period. Complex retractable assemblies are thus no longer necessary and production can resume almost seamlessly and without any long delays.

Filling

In the filling process, the pH value is used as a reference measurement to enable reproducibility and ensure that only pure beer is bottled. This measurement point is extremely important when it comes to quality assurance and ensuring consistent taste.

Flushing water treatment

Reusable bottles are rinsed and cleaned in the bottle washing system. The ratio of additives and flushing water needs to be adjusted precisely to ensure a residue-free result. For this purpose, the pH value of the flushing water needs to be measured continuously. To remove all flushing water residues and prevent

changes in taste during filling, the bottles need to be flushed with neutral water at the end of the process. During chlorination of the bottles, both the pH value and the redox potential need to be measured to ensure consistent sterilization. Since the Pfaudler pH Reiner measurement probe is capable of measuring both parameters at the same time, this reliable and maintenance-free measurement system contributes to increasing profitability and plant safety.

Waste water treatment

About 3-5 liters of water are used in the production of 1 liter of beer. Certain specifications with regard to temperature and pH value need to be met in order to be able to discharge the brewery waste water into the municipal sewage system.

The pH value must be between 6.5 pH and 9.5 pH, which is achieved by adding the necessary amount of acids or bases to the brewery waste water. Given that the corresponding measurements need to be documented throughout the entire process and made available to the authorities, they should be as reliable as possible and require low maintenance efforts.

Comparison of two measurement principles

The pH value can be measured by two different principles: the absolute measurement principle and the differential measurement principle. Both measurement principles were used in the process to produce a comparative analysis.

The pH Reiner probe, which uses the absolute measurement principle, was calibrated using two buffer solutions and then installed.

The differential measuring pH 18 probe was calibrated using the process point directly before wort clarification. This way, it can be checked whether the mashing and wort boiling processes yield the same target pH value in every batch.

The considerable decrease in the pH value during mashing as seen in the diagram is caused by adding malt grind. After this process is completed, the mash is fed into the lauter tun to separate the wort from the grains. The increase in the pH value during lautering is due to the fact that both pH probes were not in contact with the medium. The wort was pumped back to the wort kettle after lautering and heated. Hops were added at a temperature of approx. 95 °C, which led to a slight decrease in pH.

The aromatic substances contained in the hops can only develop optimally if the temperature is increased gradually over a certain period of time. After this process, both measurement probes must produce the same desired pH value in order to start the process of wort clarification. The matching values can be seen in the diagram (see Fig. 2) at the intersection between wort boiling and wort clarification.

Summary

The use of Pfaudler pH probes unlocks numerous benefits when it comes to increasing process quality and plant safety. Their long service life and stable measurement characteristics translate into considerably lower maintenance efforts, while producing reliable inline measurement results at any time.

The robust hygienic design minimizes the risk of glass breakage and the resulting risk of product contamination. Operating and production times are optimized thanks to the probes' short regeneration time after CIP processes, and without the need for retractable assemblies.

Despite the higher purchase price compared to conventional glass probes, the life cycle cost of glass-lined pH probes prove to be lower in the long term. □

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