Inline measurement of wort concentration on the lauter tun

MONITORING OF BREWING PROCESS | For reasons of quality and efficiency, continuous wort monitoring in breweries is recommended. Using inline analytical instrumentation, wort concentration can be measured directly in the process every second. Warsteiner Brauerei has installed inline measurement systems for automatic process monitoring and control many years ago. Several measuring points on the lauter tun, wort boiler and wort cooler have been equipped with the LiquiSonic® Plato system supplied by SensoTech, Magdeburg. The measuring point on the lauter tun is important, in particular for optimizing wort yield.

USING INLINE ANALYTICAL INSTRUMENTATION, the progress of concentration in the wort during lautering can be followed rapidly and accurately. In order to maintain beer quality, spent grains should not be leached excessively. Accurate determination of extract concentration at the end of the lautering process (point to cut runoff) is thus important to ensure good beer quality with simultaneous good yield.

In terms of economics, the cost situation can be improved by optimizing consumption of water and raw materials and improving lautering times.

Inline analytic instrumentation both monitors and continuously documents the whole progress of lautering (first wort, spargings, runoff). In this way, many relevant process parameters, such as original gravity, type, temperature and initial extract in the copper, can be continuously stored so that every lautering run can be re-examined. Data is supplied to the control system via the periphery of the measuring instrument and provides for automatic process control. Process fluctuations can thus be equalized or readjusted so as to obtain a reproducible and consistent high wort quality.

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Fig. 1 Measuring point on the lauter tun in Warsteiner Brauerei

Automatic integration in the process cannot be achieved with laboratory measurements. Apart from labour intensive sample withdrawal and analysis, the results are time-delayed, data and documentation is point reading only.

Various measurement methods are available for inline wort measurement, these differ in terms of suitability and user-friendliness. When measuring concentration using ultrasonic methods, the sensor can be installed directly in the pipeline on the lauter tun or mash filter discharge. No bypass is required. Some ultrasonic measurement instruments are maintenance-free and do not accumulate deposits.

Use in Warsteiner Brauerei

Some time ago, Warsteiner Brauerei decided on measurement systems that measure wort at various points in the brewhouse using ultrasonics. Following detailed comparisons and coupled with long-term experience, it was decided in 2010 to install the system at additional measuring points. Satisfactory results had been achieved by having SensoTech systems installed in the brewhouse of the pilot brewery. Several LiquiSonic measuring points were identified on the lauter tun, wort boiler and wort cooler in the production process of Warsteiner Brauerei. The measurement system comprises one or several immersion sensors and a controller being used as evaluation unit.

In order to measure the wort on the lauter tun, the immersion sensor with Varivent connection was installed directly in the DN 65 (2.5") pipeline on the lauter tun discharge. Figure 1 depicts the measuring point in Warsteiner Brauerei. The sensor

Fig. 2 Immersion sensor with Varivent process connection and integrated electronics

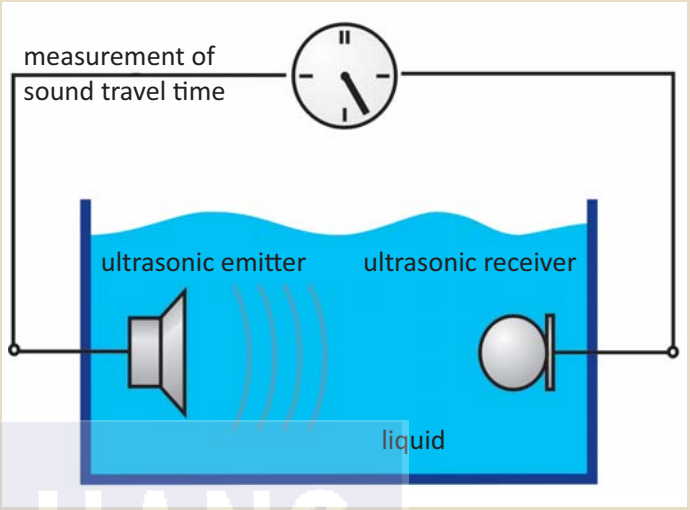

Fig. 3 Measurement principle of LiquiSonic® sensors

is completely in stainless steel DIN 1.4571 (equivalent to 316 Ti). The electronic elements are in a remote stainless steel enclosure as an ambient temperature of 50 °C might arise under the lauter tun in Warsteiner Brauerei. When the ambient temperature is lower, a sensor with integrated electronics can be installed (fig. 2).

The sensor fork is of robust and completely sealed design, it does not require seals or "windows" to the process. The electronics enclosure with an IP68 degree of protection can be cleaned together with the process units e.g. using high-pressure jets or steam. Measurement is easily possible in pipelines with different nominal sizes because the sensor installation length is variable. This is a result of the overall local process conditions described. A number of alternatives are available for selecting the type of process connection. If the pipeline has no process connection at the required measuring point, the sensor can be integrated in the pipeline e.g. by using an inline

COMPARISON OF VALUES MEASURED INLINE AND IN THE LABORATORY AT WARSTEINER PILS

Process value (°P)	Laboratory value (°P)	Deviation (°P)
16.03	16.08	–0.05
16.15	16.19	–0.04
15.99	15.98	0.01
16.09	16.06	0.03
16.12	16.17	–0.05
16.08	16.12	–0.04
16.08	16.10	–0.02
15.85	15.82	0.03
16.03	16.05	–0.02
16.01	15.97	0.04
16.17	16.15	0.02
16.17	16.14	0.03

Table 1

enclosure. Measurement takes place at the sensor fork, with one end of the fork sending an ultrasonic signal to the other end. Measurement is based on travel time measurement that detects signal speed or sonic velocity. Sonic velocity changes as a function of material composition. Resulting from the functional relationships, concentration can be calculated based on sonic velocity. Figure 3 illustrates the measurement principle described.

Economics and measurement accuracy

"By installing analytical instrumentation, we are in a position to ensure that beer quality remains consistently high and we can produce in a resource-efficient manner. We therefore monitor the whole lautering process. We are particularly interested in the runoff switch-over point. Apart from the known influences on quality when reusing runoff, rising energy costs are increasingly important. Prolonged sparging of spent grains, i.e. an increase in yield, is offset by rising energy costs because more water results in lower wort concentrations, leading to a longer evaporation phase and thus additional energy costs", according to *Michael Wiegelmann*, Production Manager. "The sensor does not accumulate deposits and is not subject to measured value drifts. We obtain reproducible and reliable data, both in the high original gravity range as well as for runoff. This is important as every gram of yield is nowadays desirable. Barley raw material prices have risen considerably, and high-precision original gravity measurement is indispensable".

When ensuring high quality standards and robust unit operations with integrated and resource-efficient switch-over points, high measuring accuracy is of overriding importance. Measured values obtained in the lab and inline were compared. Table 1 shows that a measurement accuracy of about ± 0.05 °P is obtained. "It is true that we have minor deviations compared to laboratory measurements. However, these have to be measured manually, processing and reaction times are too long, measurement is not continuous. The pros and cons have to be weighed", according to Michael Wiegelmann. In his opinion, inline instrumentation is, ultimately, the preferred option.

Fig. 4
Ludger Bräutigam, Technical Production Warsteiner Brauerei, at the controller

Easy evaluation

Values measured inline are visualized and managed by a controller. Up to four sensors can be connected to it. At Warsteiner, this had been advantageous in terms of investment costs. The measurement system described is installed on two lauter tuns, with both sensors being connected to the same controller. An integrated logbook is used for data storage and documentation so that processes can also be checked retrospectively. Up to 32 different beer recipes can be inputted in the controller and activated via automatic product switch-over. The display shows both wort concentration and temperature.

The whole process can be tracked clearly in the trend view as concentration values unfold over time. When predefined values are exceeded or not reached, a digital signal can be emitted so that it is possible to react immediately.

The controller is equipped with analogue and digital inputs and outputs and, in Warsteiner Brauerei, was integrated comfortably in the process management system using Profibus DP. *Ludger Bräutigam*, Production Operative, points out: "It is easy to operate the instrument, it has many useful additional features. It is, for example, possible to access the controller remotely via modem or Ethernet. This has been very convenient for us because we had the support of the manufacturer during commissioning" (fig. 4).

Initial extract measurement in the copper

For optimization of wort concentration for the subsequent boiling process, the EXtrACT Totalizer can be installed on the lauter tun, this is displayed in the controller as an option. It measures the median wort concentration in the copper by combining the system with a flow meter. This ensures quality-assuring and efficient coordination of lautering and boiling, optimal plant utilization and having state-of-the-art starting parameters for wort boiling. ■