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Process Analytics

Dissolved O₂,
Dissolved CO₂,
Gas O₂, Turbidity,
pH and Conductivity
Measurement
Solutions

In-line Analytical Measurements for Brewing Process Optimization

METTLER **TOLEDO**

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Brewing Process Optimization with In-line Analytical Measurements

In brewing operations, it is crucial that process reliability is always high and consistent. Central to this aim is timely measurement of analytical parameters in wort, beer, water, and gaseous CO₂. Although analysis of grab samples offers accurate results, it is time-consuming, carries the risk of non-representative samples, and does not supply continuous, real-time data. In-line measurement using process analytical equipment reduces the workload of laboratory staff (measures directly in the process, eliminating the possibility of inaccurate measurement results) and supplies a constant stream of real-time data, allowing rapid corrective action when necessary. Most significantly, in-line analytical measurements enable reliable, consistent production of beer.

METTLER TOLEDO has many decades' experience in developing and manufacturing analytical measurement solutions that meet the particular needs of the brewery and beverage industries. Through listening to our customers across the globe, we have continued to innovate and improve our sensors and transmitters. This long-standing experience led to the development of the Intelligent Sensor Management (ISM) concept, a technology embedded into our measurement systems that provides a wide range of benefits including predictive diagnostics for higher operational uptime, reduced maintenance and secure calibration of sensors. ISM therefore lowers overall instrument lifecycle costs.

This booklet contains a collection of documents related to brewing process monitoring and control. It highlights different analytical measurement challenges breweries may face when endeavoring to optimize their manufacturing operations. Several critical processes are outlined in case studies in which solutions and their implementation are detailed. The booklet serves to help managers, engineers and technicians find the most appropriate measurement solutions to make their processes smarter and more cost-effective. In these articles, you will find out how to take advantage of in-line oxygen, CO₂, turbidity, color, and conductivity measurements in the following production steps:

- Brew house
- Fermentation
- Storage
- CO₂ recovery
- Filtration
- Carbonation
- Blending
- Filling

Turbidity Measurements in the Brew House

The best beer relies on the best wort. From mash tun to whirlpool, in-line process analytical measurements help ensure your finished products retain the flavor you want throughout their shelf life.

Wort clarity

The role of brew house operations is to achieve a wort of the best possible clarity, since wort with too high a degree of turbidity can negatively influence both the taste and the storage life of the beer.

Process

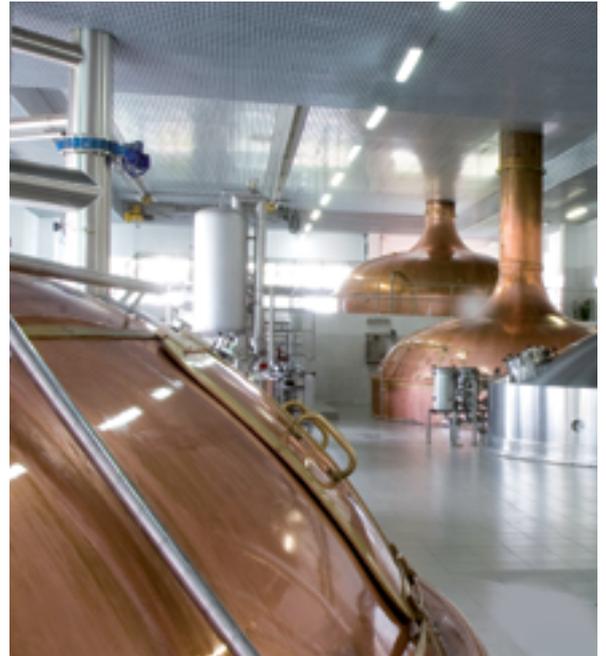
The mashing process stage, in which the starch and protein content of the malt is subjected to various conversion and dissolution sequences, results in the formation of a mixture of wort (liquid phase) and spent grains (undissolved substances = draff). In the next process step, lautering, the draff is separated from the wort by filtration and sparging. This is carried out in a lauter tun in stages which include:

- recirculation of turbid wort
- drawing off of the first wort
- sparging / last runnings.

These three operations can be monitored and controlled by using an in-line turbidity sensor installed in the main collector line of the lauter pipes (Fig. 1).



Fig. 1: InPro 8600 turbidity sensor



Trub wort pumps

The draff takes on the function of a filter by settling down to the false bottom of the lauter tun, thereby forming a filter bed. The initial outflow of wort from the tun is always turbid since the filter bed is still in the process of formation. As soon as the build-up has been completed, the wort becomes clearer and no longer has to be recycled to the lauter tun, but can be fed directly to the wort copper. This development in clarity is registered by the turbidity measurement system which can then automatically switch over the trub wort pumps from the recycling function to the lautering sequence.

Run-off of the first wort

The wort which is now pumped from the lauter tun to the wort copper is known as the first wort. The signal from the turbidity measurement instrument is used to control the knives of the draff cutting device in the lauter tun. On an increase in the turbidity of the wort, the cutting device is raised, and at a decrease, lowered. This ensures first wort runoff of uniform rate and clarity is maintained.

Sparging

In order to maximize malt extraction, sparging water is introduced into the lauter tun. This is done in order to withdraw as much residual wort as possible from the draff. In this procedure too, operation of the cutting device is automatically controlled via the turbidity signals, typically in combination with a differential pressure measurement. Control of the cutting device on the basis of the level of turbidity results in being able to achieve wort with a low turbidity throughout all phases of lautering. With the use of modern lautering tuns, it is quite possible to achieve worts with a value lower than 10 EBC turbidity units.

Whirlpool

In the whirlpool, the hot break (particles which precipitate during wort cooking) is separated from the liquid phase. In the whirlpool outlet, an in-line turbidity system can be used to monitor the hot wort clarity for charge traceability and quality assurance purposes.

METTLER TOLEDO solution

The collection of standard methods of the Central European Brewing Technology Analysis Commission

(MEBAK) recommends that during lautering, a sensor is used which measures particles on the basis of the forward light scattering technique. In this way, a good correlation between solids concentration and the measured value is achieved. The concept of the InPro 8600 sensor is in accordance with this technique, whereby through simultaneous measurement of forward and sideways scattered light, compensation of disturbing influences such as differences in wort color, possible light intensity changes of the sensor's LED, and soiled windows is effected. The InPro 8600 with sapphire glass, and fully compatible with CIP procedures, has been designed for direct insertion into the main flow line of the lauter tun and whirlpool via a GEA Tuchenhausen Varinline® connection.

The measurement system is configured via the transmitter type M800 (Fig. 2) which features intuitive full text menus. This enables rapid and straightforward start-up and configuration during everyday operation. The reading of the turbidity value is given directly in EBC turbidity units. 4 to 20 mA outputs are available in order to integrate the turbidity signal into the overall process control system.



Fig. 2: M800 transmitter

Turbidity Measurement at the Lauter Tun Improves Productivity and Quality

Case Study

In-line turbidity measurement provides a reliable way of verifying the performance of the separation of the wort/solids. After years of successfully using METTLER TOLEDO's InPro 8400 turbidity sensor in the lauter tun, the InPro 8600 has surpassed our customer's expectations in providing reliable measurement values as well as being simple to install and maintain.

Brazilian brewer

Our customer, one of Brazil's biggest players in the brewery market, produces a beer known the world over and must meet the brand's owner's international quality standards. The brewery has always acknowledged METTLER TOLEDO as a supplier of state-of-the-art technology, and has successfully used our InPro 8400 turbidity sensor for many years.

Due to that sensor's performance and our post-selling services, METTLER TOLEDO was contacted to supply a turbidity system for another lauter tun in which the same beer would be produced. We were able to offer the InPro 8600 with ISM technology, a sensor with improved performance and enhanced features to meet the customer's demanding needs.

Lauter tun turbidity

Turbidity and dissolved oxygen are the two most important analytical variables to be measured in a beer plant. Among turbidity applications, the most commonly known are after the lauter tun and after final beer filtration. In both positions our customer has installed InPro 8600 sensors. While in the first case a



one-angle turbidity sensor model is employed, in the second a two-angle sensor model is required for monitoring the particle size trend.

In the lauter tun, starch and proteins present in the malt go through several steps of conversion and dissolution, resulting in a liquid phase – the wort, and undissolved substances consisting of spent grains.

The turbidity signal is the perfect way of deciding when the wort is at the stage where it can progress through the process, i.e., when wort turbidity is sufficiently low. If solids are carried forward, yeast metabolism is altered, resulting in low productivity. Moreover, solids can also carry unwanted components which may impair the final taste of the beer. In this specific case, a 4 to 20 mA output is used to control the lautering, where the 4 mA signal corresponds to 0 EBC and the 20 mA corresponds to 50 EBC.



Intelligent solution

The InPro 8600 with its digital signal, and the Trb 8300 D transmitter, surpassed the customer's expectations, specifically because of the system's Intelligent Sensor Management (ISM) technology.

ISM greatly improves sensor handling, reduces maintenance costs and increases process safety. The Plug and Measure feature means that the sensor is ready to use as soon as it is connected to the transmitter. The InPro 8600 is shipped from METTLER TOLEDO already calibrated and this data is automatically uploaded to the transmitter upon connection.

As the InPro 8600 has no O-rings or light bulbs that need replaced and the windows are made of scratch-resistant sapphire glass, almost no maintenance is required.

Clearly better wort

In-line turbidity control guarantees uniform wort quality. If not controlled, beer taste can be damaged and shelf-life decreased due to the drag of solid components.

Now, for our customer, wort of the best clarity possible is obtained.



InPro 8600 turbidity sensor

Reproducible Fermentation Conditions

DO Control in Wort Aeration

Case Study

The dissolved oxygen level during wort aeration has to be controlled to prevent the beer being adversely affected. For a major Thai brewery, use of METTLER TOLEDO optical DO sensors during cold wort processes has led to improved wort aeration and increased process uptime.

Top Thai brewery

The brewery industry in Thailand started in 1934, and despite competition from major international brands, local producers have successfully established themselves in their own country and abroad.

Our customer is one of Thailand's three major beer producers. In the north of the country they operate a facility with a production capacity of 10 million hectoliters, making it the biggest brewery plant in the country.

DO measurement in aeration is essential

The customer has two lines for cold wort aeration. Control of the process through dissolved oxygen measurement is a very important step, as excessive aeration causes oxidation of wort ingredients and insufficient aeration slows fermentation. Both situations lead to reduced production and lower beer quality.

DO measurement systems using amperometric probes were installed in both lines. Due to plant design, retractable housings that would allow the sensors to be removed during CIP cycles, could not be installed. Exposure to the CIP caustic solution, hot water and the high sugar content of the wort was taking a heavy toll on the probes. Measurement accuracy of new sensors would quickly fall which meant regular and time-consuming maintenance to replace sensor membranes.

The brewery was looking for an alternative solution that would be durable and low maintenance and that could be installed in the same measuring positions. METTLER TOLEDO suggested a system based around the InPro 6960i optical DO sensor.



Benefits of optical technology

The optical technology in the InPro 6960i offers many advantages over other sensor designs. Unlike amperometric probes, the InPro 6960i requires no polarization before it can begin measuring; therefore, sensor start up is almost immediate. Very low drift is another feature of optical sensor technology, so measurement stability remains high over a long period. Servicing is quick and simple as no electrolyte solution is involved. The only part of the probe that requires periodic replacement is the OptoCap sensing element which contains an oxygen-sensitive layer. The OptoCap is more robust than the membranes of amperometric probes, and its lifetime can be extended by selecting a longer sampling rate and automatically turning off the sensor's internal LED during CIP cycles.



Built-in intelligence

The InPro 6960 i is one of METTLER TOLEDO's expanding portfolio of sensors featuring our Intelligent Sensor Management (ISM) concept. ISM brings benefits to working with process analytical systems by simplifying sensor handling and reducing maintenance. Thanks to ISM technology, the InPro 6960 i automatically detects CIP cycles via an integrated temperature probe. The number of CIP cycles, sampling rate, operating time and other wear and tear related data are used to predict the remaining reliable lifetime of the OptoCap. This is displayed on the connected transmitter as the Dynamic Lifetime Indicator (DLI). When the DLI reaches zero, the measurement system generates an alarm for OptoCap replacement. As a result, unwanted use of a potentially failing sensor is avoided.

The M400 was selected as the partnering transmitter for the sensor. The M400 is a versatile multi-parameter transmitter series that offers full support for ISM functions. It accepts analog sensors as well as digital ISM sensors, adding to its flexibility.

Improved wort aeration

Once installed and operating, our customer was pleased to find that lab measurements closely agreed with those from the InPro 6960i, proving that the influence of CIP cycles on the sensor were minimal.

Our customer is extremely satisfied with the performance of the system. The longer maintenance intervals and DLI have significantly increased process uptime. Of most importance to the brewery, the reliable values from the InPro 6960 i have led to improved wort aeration and smoother production, and are helping them brew beer of the highest quality.



InPro 6960 i optical DO sensor

Optical Product Monitors in the Brewing Process

In the highly competitive beer industry, cost optimized production is an important cornerstone of successful brewing operations. Furthermore, the risk of interruption to the filling process caused by using the wrong or a contaminated product must be minimized. Optical product monitors are the ideal solution.

Benefits

Optical product monitors are invaluable in minimizing beer losses and optimizing yeast recovery processes. The real-time identification of the current product in the filling line and an early alarm in the event of an unwanted product change, increases process safety and avoids unscheduled downtimes.

Process

Typically, turbidity monitors are installed in the outlet of cylindroconical fermentation and storage tanks. Compared to a visual phase separation, the detection of the phase transition from yeast to beer can be fully automated with an optical product monitor. In the outlet of fermentation tanks this leads to a higher yield of yeast for the yeast recovery process. Furthermore, a low yeast concentration in green beer results in a controlled and reproducible maturation process in the storage tanks. Also, in the outlet of storage tanks the product monitor optimizes the phase separation of yeast to beer, and consequently the lower yeast concentration in the matured beer increases the operational availability of the downstream beer filter.

Another application is the installation of a turbidity monitor in the outlet of a separator. In this case, the turbidity signal is used to trigger the self-cleaning mechanism of the separator. Compared to an inflexible time controlled triggering, the loss of beer is significantly lower.



InPro 8300 RAMS Product Monitor Series

In the phase separation yeast to beer application, the standard version of the InPro 8300 RAMS monitor family is used (Fig. 1). The transition from turbid to clear is based on an absorption measurement of near infrared (NIR) light. By applying an alternative system configuration, the same unit can also be used for phase separation processes for differently colored liquids, e.g., wort and water or beer and water. In this



Fig. 1: InPro 8300 RAMS with communication interfaces in a Varinline® housing

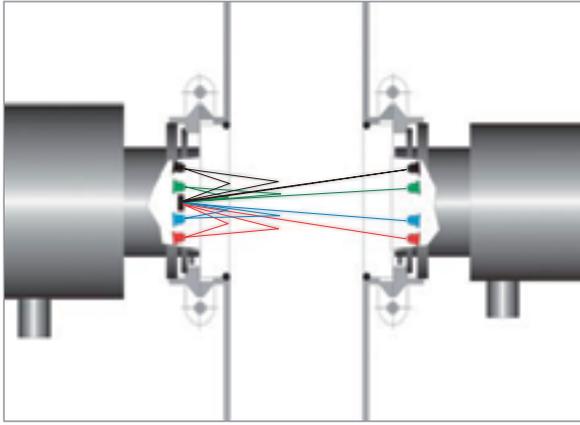


Fig. 2: Simultaneous absorption/reflection measurement at four wavelengths

set-up, absorption of blue light is measured instead of NIR light. In both cases the measurement signal is also available on a standard 4 to 20 mA output for control purposes.

For product identification in filling lines, an InPro 8300 RAMS model with four light sources is used. The simultaneous measurement of reflection and absorption of NIR, red, green and blue LEDs leads to eight

different parameters for one liquid medium (Fig. 2). In order to identify more liquids, representative “finger-prints” of the different products must be taken first and stored in the instrument. This is possible for up to eight differently colored liquids, plus colorless water. After this “product learning” procedure, the different media will be accurately identified during the filling process. Digital signals are used to transmit the information to a DCS or PLC.

All members of the InPro 8300 RAMS product family are easily installed on Tuchenhausen Varinline® housings. They are further characterized by a reduced maintenance requirement thanks to the use of long life LEDs and CIP resistant materials. A PC software package is available for the above mentioned product parameterization via the integrated RS 232 interface. The only calibration procedure necessary for all InPro 8300 RAMS versions after a certain period of use (typically after one year) is an in-line zero point correction. In this case, the InPro 8300 RAMS unit stays in the pipe, which is filled with clear water, and the offset is corrected by the simple push of a button.

5,000 Hectoliters of Beer Saved with an Optical Product Monitor

Delays in determining water to beer transition are costly to breweries. A number of methods exist for product transition monitoring, but an optical system is the quickest and most reliable. For a brewery in Brazil, the InPro 8300 RAMS is saving thousands of liters of product per month.

Operator determination of product transition can be wasteful

Breweries have a great need for precise, timely identification of product transition as it reduces product loss and water wastage. Methods vary, and determining product transition by simple, visual means using a sight glass is still common. This approach relies heavily on operator skill; therefore, the point at which the appropriate valve is switched may be too early or too late depending on each individual operator's abilities. Considering typical pipe diameters and speed of the fluid, a delay of only a few seconds equates to a significant quantity of product being wasted or water diluting the beer.

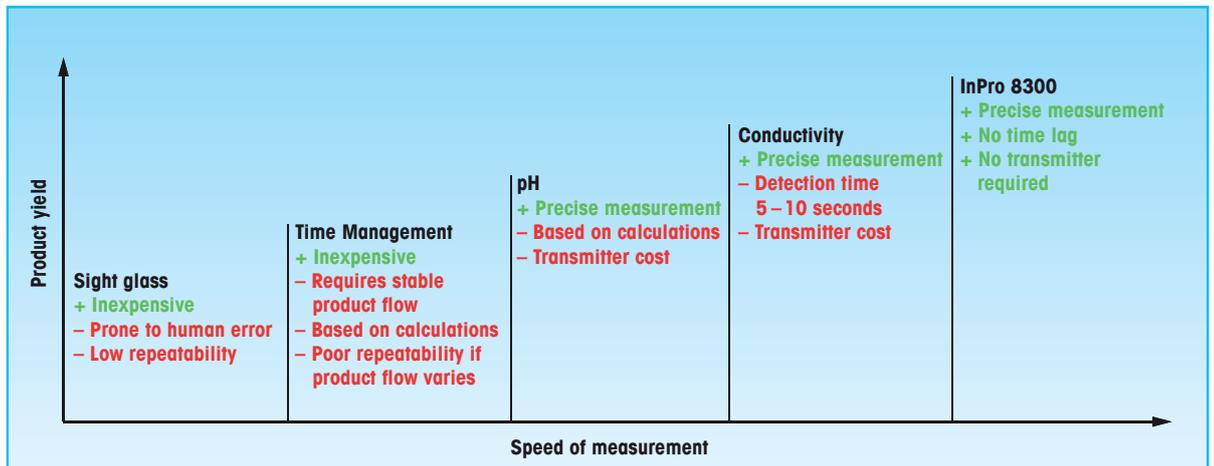
One of the world's major players in the beer industry operates a facility in Brazil. Brewery engineers were keen to replace the sight glass between fermentation and carbonation tanks with a cost-effective automated system.

In-line product monitor reduces beer loss

The InPro 8300 Reflection Absorption Multi-Switch (RAMS) optical product monitor is highly suited to this type of application. The RAMS series of products use transmitted and back-scattered light to precisely determine liquid color and /or turbidity in real time. Installation is simple as the InPro 8300 RAMS is usually a retrofit for an existing sight glass housed in a Tuchenhagen Varinline® process connection. For the Brazilian brewery's situation, a color identification model was installed. Once the



output of the unit (4 to 20 mA) was correctly set for triggering the appropriate valve, the InPro 8300 RAMS could be left to reliably monitor and control water / beer transition.



A comparison of phase separation technologies

The InPro 8300 RAMS not only eliminates the risk of operator error, it has advantages over other methods of product determination such as time management and conductivity measurement (see graph above).

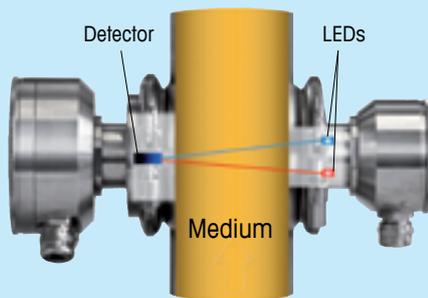
More beer, better quality, reduced cost

Using the METTLER TOLEDO system has brought our customer the following benefits:

- Improved efficiency through reduced product loss (approximately 5,000 hectoliters saved per year)
- Greater control of product quality due to continuous monitoring of color in the process
- Cost savings by reducing manpower at the process

InPro 8300 RAMS

The InPro 8300 RAMS measures light absorption and reflection from LEDs to determine colour and/or turbidity. This technique is sensitive to even slight changes in the color or optical density of a liquid and responds almost instantaneously. A choice of optical parameters provides the option to monitor product transitions based on optical turbidity or color measurement, similar to an in-line photometer. For turbidity measurement a near infrared (NIR) LED (880 Nm) light source is used to measure forward scattering through the liquid.



By using NIR light the turbidity measurement is mostly independent of color influence. For product transitions based on color measurement a blue LED (430 Nm) is used.

Process integration is achieved by implementing the 4...20 mA signal transmitting the turbidity or color measurement to a suitable PLC – no transmitter is required. The measurement signal is repeated more than five times per second providing a response time of less than 200 ms.

Self-Sufficient CO₂ Production in the Brewing Process

Recovered fermentation CO₂ can be stored and used in carbonation. The required quality can be obtained through in-line control with the InPro 6950 i G oxygen gas sensor. As a result, considerable cost savings are achieved.

To buy or to produce CO₂

Soft drinks producers and other segments of the Food and Beverage industry use carbon dioxide (CO₂) in their production processes. But in the brewing industry, CO₂ is a by-product of the fermentation process and is used to displace air from tanks, cans, bottles, and kegs before they are filled with beer and therefore protects and ensures the quality and uniformity of beer. In many cases, CO₂ is also incorporated directly into the product. In these applications, either recovered or purchased commercial CO₂ is used.

Self-sufficient CO₂ production

In many breweries there is a desire to become or remain self-sufficient in their CO₂ production for use in their processes. To be self-sufficient, a brewery must be able to produce enough CO₂ and have the storage capabilities to meet the demands throughout the entire production process.

They must also balance the cost of purchasing CO₂ with the cost of the collection system and the operating costs associated with purifying, storing, and distributing recovered CO₂.

Standards of purity in the beverage industry

In the case of both purchased and recovered CO₂, the quality of the products needs to be monitored for impurities. CO₂ used in these applications should have a purity of at least 99.98%. The International Society of



Beverage Technologists (ISBT) has suggested standards upon which impurities in CO₂ must be analyzed for public safety. Trace detection of ppm levels of O₂, THC, H₂O₂ and total sulfides in CO₂ used in the production processes need to be monitored.

Purity requirements in brewing industry

In breweries, the monitoring of the ppm level of O₂ in the CO₂ is a typical application.

O₂ present in the CO₂ will dissolve into the process in the liquid phase and cause oxidation of the beer affecting flavor, color and shelf life. Purity standards for CO₂ are typically less than 30 ppm for O₂. Oxygen measurement systems are used throughout the collection and recovery system to monitor O₂ levels. Using an O₂-gas measurement system at the collector head of the fermentation tanks to trigger whether to vent or collect, can result in longer collection times and less

wasted CO₂. Monitoring CO₂ after the vaporizers of the recovery plant ensures the CO₂ being sent to the brewing or packaging meets purity requirements.

METTLER TOLEDO solution

METTLER TOLEDO's sub ppb sensor InPro 6950i G for O₂ detection is specifically designed for this application. The sensor will accurately measure CO₂ levels in the oxygen without the extensive process conditioning required of other available monitoring systems. The rugged design of the sensor will also withstand the pressure fluctuations seen on the collection system, reducing downtime and maintenance.



InPro 6950i G oxygen gas sensor



Suntory Reduces Waste of Carbon Dioxide with In-line, Real-time Monitoring

Recovering and re-using CO₂ greatly reduces beer production costs. To ensure the quality of their recovered CO₂, Suntory chose a METTLER TOLEDO system.

Leading brand in China

Established in 1998, Suntory Brewing (Kunshan) Co., Ltd. is a successful development of the Japanese Suntory Co., Ltd. in China. It is located in Kunshan City, Jiangsu Province and has an annual beer production capacity of 200,000 tons. The beers manufactured by the company are widely sold in the north-eastern Chinese market and it has become a leading brand in the region.

Reduced cost of CO₂ use

CO₂ is an extremely important raw material in beer production, and in the past the brewery had to spend a vast amount on purchasing high-purity CO₂ from external sources. Suntory therefore decided to install a CO₂ recovery system.

Application

The system measured the purity of CO₂ by means of manual sampling in the laboratory. It was usually calculated four times per shift, and once unqualified CO₂ was found, the gas would be discharged or processed again. This method had two problems: Manual measurement errors arose, and determining when to measure could not always promptly discover a change in CO₂ purity, so appropriate measures could often not be adopted in time to avoid CO₂ being wasted.

To counteract this, Suntory took the decision to install in-line oxygen measurement equipment to monitor the processing efficiency of the CO₂ recovery system. After comparing products of different brands, the brewery chose a METTLER TOLEDO in-line oxygen measurement solution comprising the InPro 6950 Gas sensor and M700 transmitter. From the information obtained from the system, engineers can easily calculate the purity of the recovered CO₂ (Fig. 1).



Installation

To conduct in-line monitoring of oxygen content, the InPro 6950 / M700 system was installed at the CO₂ dryer outlet. The system can automatically issue an alarm in the event of out-of-spec quality in order to prevent a substandard CO₂ supply on the one hand, and on the other, to alert engineers to take corresponding measures in the event of abnormal purity of recovered CO₂. At the outset, after the system's installation and implementation, it was

CO ₂ Purity	Residual O ₂ Concentration in CO ₂
99.998 %	5 ppm v/v
99.99 %	20 ppm v/v
99.98 %	40 ppm v/v
99.97 %	60 ppm v/v
99.90 %	200 ppm v/v
99.70 %	600 ppm v/v

Fig.1: Comparison table between CO₂ purity and oxygen density in CO₂

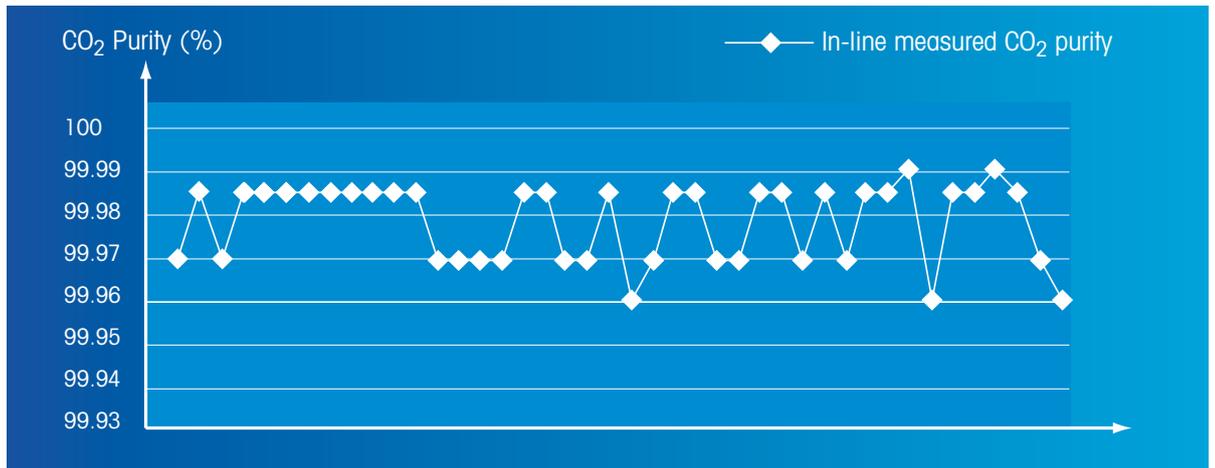


Fig. 2: In-line CO₂ measurement before pressure adjusting device fitted.

discovered that the in-line data fluctuated unpredictably and that the measurement was unstable. From the tracking record of the site measurement data and through discussions with METTLER TOLEDO engineers, it was realized that when the number of CO₂ recovery compressors in use altered, the pipeline pressure would also change, causing a distinct fluctuation in measurements (Fig. 2).

Based on discussions with our engineers, a flow-regulating and pressure-adjusting device was installed at the sample exhaust port and a pressure sensor was installed on the sample pool for in-line pressure compensation. After the improvement, the measurement

data became significantly more stable, and now when the pipeline pressure changes there is no obvious deviation of measured data.

Precise and continuous results

The improved in-line oxygen measurement system monitors the purity of CO₂ more precisely than the previous off-line method. The METTLER TOLEDO system measures O₂ continuously in real time and removes the errors that had been seen with manual measurement. When the CO₂ purity is low, the transmitter issues an alarm to prompt operators to take counter-measures, thus ensuring the quality of supplied CO₂ is always met and waste of CO₂ is minimized.



InPro 6950 O₂ sensor



“After having installed the in-line device, the purity of CO₂ can be monitored more promptly and CO₂ waste due to untimely manual measurement is avoided. In addition, the METTLER TOLEDO analyzer is simple to use and maintain”.
Meng Fanwa, instrument engineer at Suntory Brewing (Kunshan)

Turbidity/Color Measurement in Breweries

One Sensor for Three Signals

In a modern brewery, more and more quality-related parameters are measured directly in the process. Benefits of such real-time measurement data are better plant control and optimization of several process steps without time delay. Visual parameters such as beer brightness and beverage color are evaluated by the quality-conscious consumer even before he starts to drink.

Beer filtration and filling

The brightness of a beer – the absence of turbidity – is typically measured in European Brewery Convention (EBC) or American Society of Brewing Chemists (ASBC) units. In filtered beers, the turbidity is typically smaller than 1 EBC, which equals 69 ASBC. Turbidity is directly measured in the outlet of a Kieselguhr or membrane filter, and in filling lines. In a dual scattering angle system, both 90° and 25° light intensities are measured simultaneously. The 90° EBC/ASBC value is directly related to the concentration of small undissolved particles, for example beer proteins and glucanes. The 25° measurement plays the part of a “watchdog” in these applications due to its higher sensitivity to non-beer components such as yeast cells and Kieselguhr particles. Unwanted filter breakthroughs are detected very reliably and quickly via this scattering angle.

Blending processes

In the high-gravity brewing process, the original-extract content is adjusted by blending beer with deaerated water. In some cases, coloring beer is also added to produce darker beers. Beer-based beverages are produced by blending the beer with soft drinks or flavor compounds. Typically, these blending steps take place after beer filtration. In addition to the determination of the original-extract-content, color measurements based on the EBC method provide important information on the final beverage appearance: consistent color and clarity being major goals of high quality. The beverage color – or to be exact, the yellowness – is measured by the absorbance of light of a characteristic wavelength. The simultaneous measurement of turbidity in the blending process and filling lines, further guarantees the absence of unwanted particles



which might have precipitated during the blending process. The presence of unwanted particles can also originate from a bad batch of coloring beer or flavoring liquid.

Turbidity measurement principle

METTLER TOLEDO's InPro 8600 is a compact, in-line, turbidity sensor that measures 90° and 25° scattered light simultaneously, using a single sensor head and a single light source. Sapphire windows are embedded in the stainless steel head and different light intensities are measured by photo detectors (see Fig.1). The direct light measurement at 0° enables compensation for background color changes, possible light source intensity changes, and for optical window fouling as well. The sensor is factory calibrated in a range from 0–100 EBC (0–6900 ASBC) using the Formazin turbidity standard. The spatial distribution of scattered

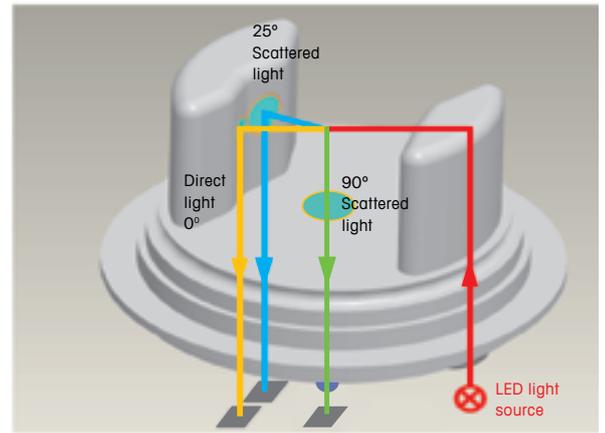
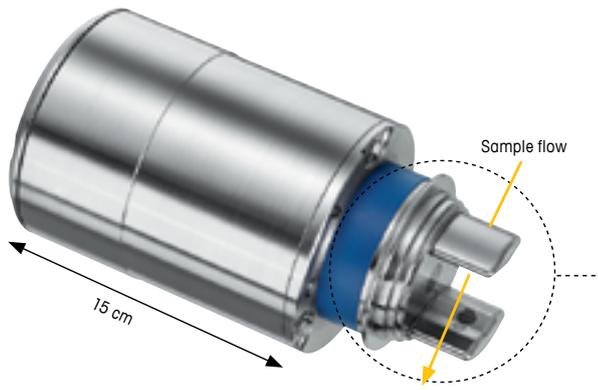


Fig. 1: InPro 8600 turbidity sensor and enlarged optical set-up, LED wavelength = 650 nm

light created by particles depends on several factors, one of which is particle size itself. Consequently, the reading of the 25° and 90° channel varies for different particle sizes. In cases where only colloidal particles (smaller than approximately 1 μm) are present in a liquid sample, the 90° channel will show a higher signal than the 25° channel. The situation reverses in situations where particles larger than 1 μm are present in the liquid. As already mentioned above, this fact is used to distinguish a normal beer filtration process from an operation in which unwanted larger particles slip through the filter medium.

Comparison of turbidity readings

Besides particle size, other parameters also influence the readings of turbidity systems. Two other factors are the scattering angle and the wavelength of the sensor light source. Therefore, it is important to note that only results obtained from the same optical set-up can be compared. Most of the turbidity systems which are

offered to breweries use a red light source (650 nm) and scattering angles of 25° and 90°, which is also the case with the InPro 8600 sensor.

Turbidity plus color

The color of beer is measured by photometric determination of the absorption of blue light in the visible spectrum. This is consistent with the EBC recommendation for the analysis of beer color. Blue light is used as at these shorter wavelengths, as it allows differences in beer color (yellowness) to be most easily distinguished. To eliminate possible sources of error in the process measurement, especially due to the interference of turbidity causing particles, the user has the possibility to apply a dichromatic method for compensation of turbidity. Technically, this is realized by measuring the red light absorption in addition to the blue light absorption. Consequently, one modification in the sensor head compared to the above mentioned set-up is

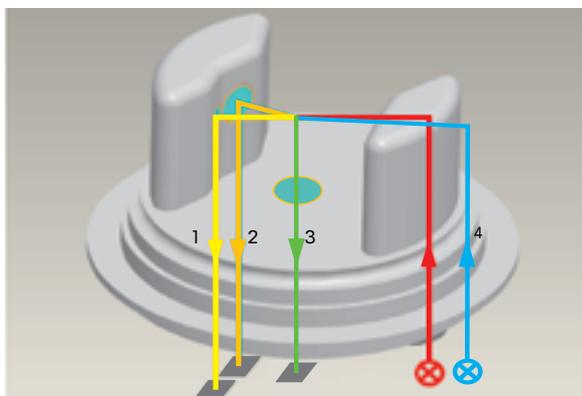


Fig. 2: Additional blue light LED for simultaneous color measurement (4). Change between red (turbidity) and blue (color) light operating mode

the addition of a blue light LED (see Fig. 2). Both blue and red LEDs are operated in deferred pulsed mode. The user is able to make use of three signals, 25° and 90° turbidity plus color, for process optimization and quality assurance purposes.

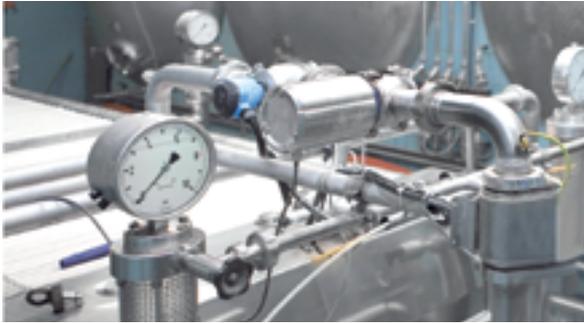


Fig. 3: InPro 8600 sensor installed in the outlet of a beer filter

Sensor installation

The InPro 8600 sensor is designed for direct installation in a GEA Tuchenhagen Varinline® access unit (see Fig. 3). The wetted materials, stainless steel and sapphire are resistant to regular clean-in-place (CIP) solutions at common cleaning temperatures, typically 85 °C. The three measurement signals are available on 0(4) to 20 mA outputs for further processing.

Measurement performance

The data obtained in a typical Kieselguhr filtration process are shown in Fig. 4. Both turbidity curves are below 1 EBC as expected for clear beer. The 90° turbidity curve shows higher values compared to the 25° turbidity curve. This leads to the conclusion that no unwanted large particles, for example Kieselguhr or yeast cells, have slipped through the filter. The color expressed in color EBC units is almost stable throughout the whole logged period of filtration time (7 EBC color units are a typical color value for a lager beer).

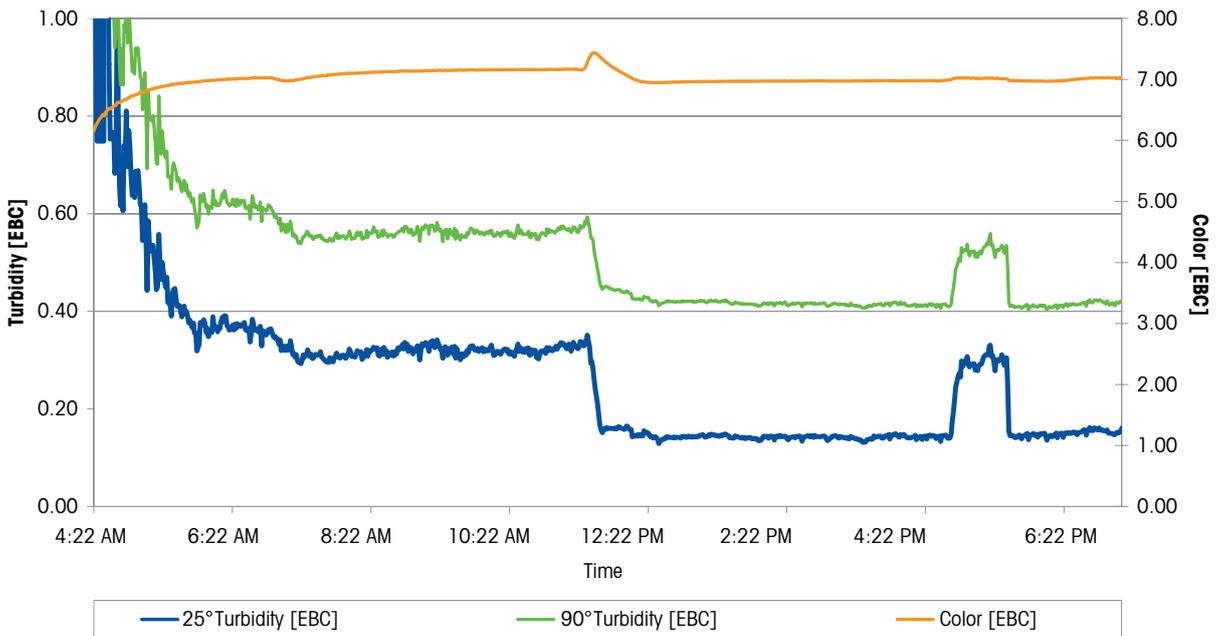


Fig. 4: The three measurement signals as observed in the outlet of a beer filter during filter operation steps

Turbidity Measurement Helps Lower Costs at Carlsberg UK

The InPro 8600 turbidity sensor combines fast, accurate results with ease of installation and low maintenance. With the sensor's help, Carlsberg UK has found a new way of reducing filtration costs.

Turbidity measurement before filtration

Carlsberg UK is a wholly owned subsidiary of the Carlsberg Group, and the UK's fourth largest brewer. It has breweries in Leeds and in Northampton, where Carlsberg has been brewed since 1973. Carlsberg has been one of the UK's leading lager brands since its introduction to the British beer market in 1868.

Following a successful trial, the Carlsberg Brewery in Leeds installed METTLER TOLEDO's InPro 8600 turbidity sensor and Trb 8300D transmitter. The trial's aim was to optimize Kieselguhr dosage during filtration based upon the turbidity of the influent beer measured in-line, rather than reacting to the turbidity of the filtered beer.

Less Kieselguhr – more profit

It was felt that controlling the dosing in this way would reduce the amount of Kieselguhr used by accurately predicting when it was required, as well as eliminating the need for re-filtration if beer was out-of-spec. Head Technical Brewer, Ian Smith, explains further:

"Powder filtration remains the most common type of filtration employed in brewing. Cross-flow filtration has been developed and is installed in some Carlsberg breweries, but it is expensive in capital and running costs and is unlikely to displace powder filtration in the near future.

"However, the cost in disposing of waste Kieselguhr is high and is likely to rise further. This is a key driving force in optimizing the use of Kieselguhr powder.

"A powder filter consists of a support membrane on which a pre-coat layer of powder is deposited. This first pre-coat does not contribute to the filtration but is a support for the second pre-coat which is the powder



that actually filters the beer. To keep the bed open, powder is added to the beer going to the filter to trap the haze material present. The rate of powder dosing required is a result of the loading of haze material in the beer. There needs to be sufficient powder added to keep the filter bed open without blinding. If insufficient powder is added, the pressure drop across the filter will rise rapidly. Once the maximum working pressure of the filter is reached, the filtration has to stop. If too much powder is added, the filter chamber quickly becomes



full and, again, the filtration has to stop. The ideal is for the maximum working pressure of the filter to be reached at the same time as the chamber becomes full.

“The normal way of achieving this is by monitoring the pressure drop across the filter and adjusting the powder dosing rate following a rule of thumb guide. The problem with this is that it is retrospective, and damage to the filter bed can occur before the problem is noticed. In practice, operators will err on the side of caution and overdose the powder. They are, however, often caught-out by localized high haze particle loadings which irrevocably increase the pressure drop across the filter. The result of all of this is an inefficient powder dosing regime.

“The object of this investigation is to make an estimate of the particle loading of the unfiltered beer, enabling the powder dosing rate to be adjusted in advance so that the operator can head off problems, rather than respond to them.”

Strong result

Initially, the dosing rate was kept constant to determine the correlation, if any, between the turbidity of the incoming beer and the ease with which it was subsequently filtered. Twelve different beers were studied and the results clearly demonstrated that an increase in turbidity resulted in a decrease in the filterability of the beer (Fig. 1).

Sample	25 ° Haze	90 ° Haze	Filterability Rating
A	107.0	80.0	Poor
B	127.0	82.0	Poor
C	35.0	19.0	Good
D	57.0	34.0	Good
E	145.0	88.0	Poor
F	> 200	158.0	Very poor
G	109.0	69.0	Good
H	60.0	35.0	Good
I	43.0	43.0	Poor
J	> 200	561.0	Very poor
K	108.0	81.0	Poor
L	52.0	51.0	Poor

The objective of the review was to create a more efficient and effective process. The new approach has the ability to increase the total filtration capacity by reducing filter downtime, resulting in a reduction in the

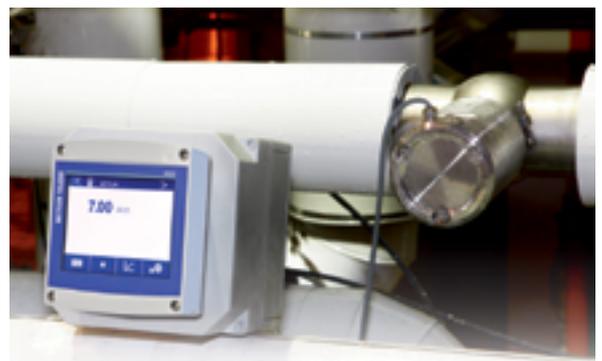


Fig. 1: Rating of filterability of 12 beers

annual spend on Kieselguhr. Ian Smith concludes, "Carlsberg UK are one of the first to take this step. In my opinion, all breweries operating powder filtration systems would benefit from having prefiltration turbidity measurement."

InPro 8600 turbidity sensor

The innovative InPro 8600 series of sensors combines advanced technology with highly accurate measurement electronics, in one compact sensor head.

Further, they provide highly reliable measurements at reduced installation costs. Key benefits are:

- Easy installation: Plug and Measure installation thanks to METTLER TOLEDO's unique Intelligent Sensor Management (ISM) technology. Sensors are supplied factory-calibrated and sensor recognition technology allows this data to be transferred straight to the transmitter. An optional wireless configuration tool means multiple sensors can be configured quickly and easily via a single PDA or laptop, saving time and money.

- Minimal maintenance effort: Optical windows are sapphire glass and have no O-rings, meaning no routine maintenance is required. The long-life pulsed LED light source eliminates the need for frequent lamp changes.
- Reliable measurement results: The InPro 8600 fully meets MEBAK requirements. Digital measurement technology provides high accuracy and fast signal response.
- Hygienic design: EHEDG certification. Fits directly into Tuchenhagen Varivent.

M800 transmitter

This highly versatile transmitter, designed for use with the InPro 8600, has been optimized for measurement of low to medium turbidities, as well as trend monitoring of particle size distribution.



InPro 8600 turbidity sensor



Turbidity transmitter M800

In-line Turbidity Measurement in the Filter Cellar

At Herforder Brewery, the InPro 8600 dual-angle light scattering turbidity sensor ensures both the quality of the beer and optimizes the filtration process.

Keg beer producer

Herforder Brewery in Hiddenhausen, Germany, was established by the Uekermann brothers in 1878. Today, total production exceeds 500,000 hectoliters, 90% of which is the Herforder Pils brand. Over a third of Herforder Pils is sold as keg beer, which makes Herforder Brewery one of the ten largest keg-beer producers in Germany.

In July 2007, the brewery was incorporated into the Warsteiner group. Both companies are family businesses with an appreciation for tradition, and can look back on a combined 375-year brewing history. Warsteiner is one of the most successful names in beer in Germany, and in 2007 achieved a production of 3.2 million hectoliters.

Use of modern measurement technology

In the past, the brightness of beer was checked by random sampling using off-line measurement in the laboratory. This had the drawback that the filtration process could not be continuously monitored. That is why Herforder Brewery decided, after a brief test phase, to purchase METTLER TOLEDO's InPro 8600 turbidity sensor which they installed downstream of the sheet filter. The sensor monitors on the one hand the Kieselguhr filter for possible breakthrough and also controls the dosing of Kieselguhr powder, both in terms of quantity and the fineness used in the pre-coating. This makes it possible to optimize filtration times and the quantity of filter auxiliary material used.

The three enemies of beer: oxygen, heat and light

The stability of beer is essentially determined by the residual oxygen concentration and storage conditions. Light, heat and oxygen promote the formation of cloudifiers that can occur through chemical reactions. When this happens, proteins and tannins are connected by oxygen links and cause clouding.



Conventional countermeasures include storage in the dark at low temperature, maintenance of oxygen concentration, and the removal of potential cloudifiers.

Importance of turbidity measurement

Filtration over the Kieselguhr filter removes proteins; in contrast, tannins are better removed by filtration using a polyvinyl polypyrrolidone (PVPP) filter. Turbidity measurement for monitoring brightness downstream of the sheet filter therefore represents one of the fundamental criteria for the stability and quality of the beer.



Don't Lose Your Fizz

Safeguarding CO₂ Measurements

Operational instrument uptime and non-ambiguous measurement values are key aspects of in-line dissolved CO₂ measurement systems installed in breweries and carbonated soft drinks facilities. Integrity of wetted sensor parts and instrument air supply are basic requirements for ensuring measurement data is always reliable. An undetected failure of the sensor can lead to costly damage of the instrument, false CO₂ readings, and wasted product.

Challenges for plant operators

Monitoring and controlling dissolved CO₂ concentrations in critical process steps helps ensure consumers experience the sight and effervescence of your products the way you want them to. Consequently, in-line CO₂ measurement systems are installed in these process steps to provide plant operators with continuous and immediate information on beverage CO₂ content, and alarms are given if levels are out-of-specification. The reliability of CO₂ sensors that use gas-permeable membranes stands and falls on two particular criteria: instrumentation for the air supply required for sensor purging, and the integrity of the CO₂-permeable membrane that separates the liquid medium from the sensing element.

The air supply requires a fixed installation including pumps, valves, hoses, fittings, and sometimes a filter cartridge in order to provide the sensor permanently with air of specified flow rate and quality. If a faulty link in the air supply chain causes the purge gas flow to fall below a critical level, operators cannot distinguish between a change in dissolved CO₂ concen-



tration and the true cause of the alteration in measurements. Operators may respond by erroneously, but understandably, adjusting CO₂ dosing. This condition can continue for some time. Only if the air flow falls sufficiently will the correct cause be recognized. This obviously compromises plant efficiency and can impact beverage quality.

It is a similar story for a drop in membrane performance: If the membrane starts to lose its integrity and allows more CO₂ to permeate and hence cause the sensor to report a higher reading, operators will reduce CO₂ dosing. As membrane integrity progressively deteriorates and CO₂ measurements continue to rise, operators will realize that changing CO₂ dosing has not been the correct action and that the sensor has been at fault. If the membrane fails entirely before it can be replaced, process liquid will come into contact with the sensor's sensing element and render it useless.

Dissolved CO₂ measurement technology

The sensor described here (see Fig. 1). uses the principle of thermal conductivity (TC) to measure CO₂ concentration. Each gas has a known TC which is the



Fig. 1: METTLER TOLEDO's InPro 5500i in-line dissolved CO₂ sensor employs thermal conductivity measurement

capacity of the gas to transport heat. It can be measured with a defined electrical circuit integrated in a TC measurement chip (see Fig. 2).

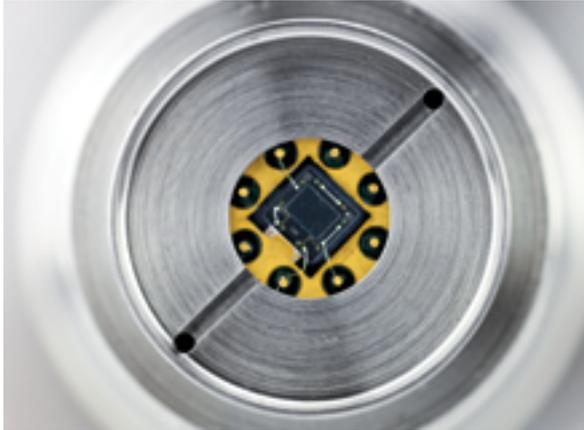


Fig. 2: The TC chip is located behind a membrane which separates the liquid phase from the gas phase

CO₂ dissolved in the beverage diffuses through the sensor's membrane and changes the composition of the gas in contact with the TC chip (see Fig. 3). The resulting change in the TC signal is proportional to the dissolved concentration.

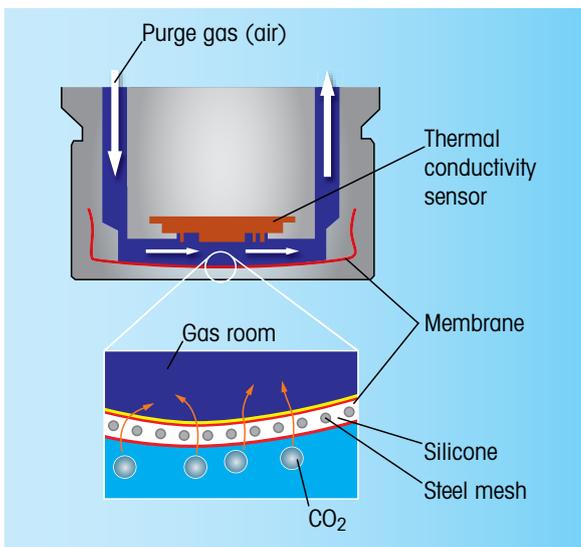


Fig. 3: CO₂ diffuses from the liquid phase through a membrane into a gas compartment where the TC chip is located

The need for air purging

The higher the CO₂ concentration gradient between the liquid and the gas phase, the faster CO₂ diffuses through the membrane. Therefore, CO₂ in the gas phase is blown out of the sensor periodically by an air purge in order to keep the diffusion driving force as large and as constant as possible. Consequently, a measurement cycle consists of an air purge phase fol-

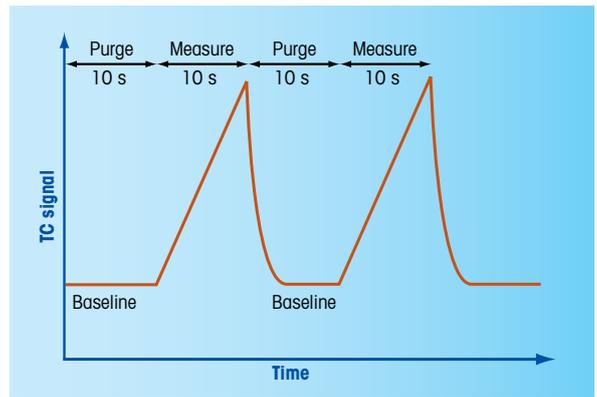


Fig. 4: TC signal during measurement cycles consisting of 10 second purges and 10 second measuring phases

lowed by a measurement phase which produces a characteristic TC signal curve for a given dissolved CO₂ concentration (see Fig. 4).

Automatic sensor protection

Only a fully-functioning TC chip leads to non-ambiguous measurement results. In order to guarantee defined working conditions of the TC chip, both the integrity of

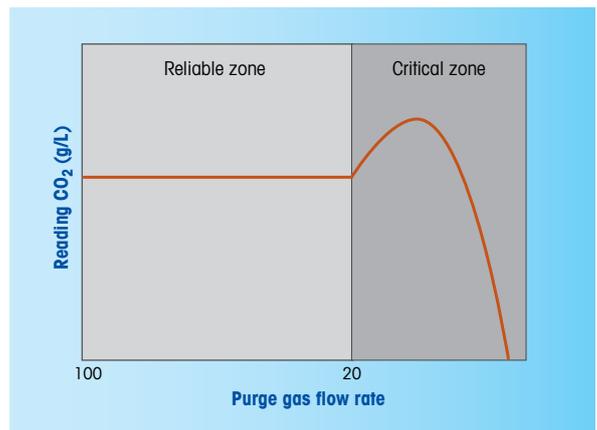


Fig. 5: Dependence of dissolved CO₂ reading on purge gas flow rate

the air purge supply and the membrane are of paramount importance. For example, the displayed CO₂ reading of the measurement system depends on the purge gas flow as shown in Fig. 5. As mentioned above, if the purge gas flow falls below a critical limit, operators cannot distinguish between an actual change in dissolved CO₂ levels and a failure of the air supply.

An initial loss of integrity of the gas-permeable membrane leads to a greater diffusion rate of CO₂ and is, in the worst case, followed by leakage of process liquid into the gas compartment of the sensor which could damage the chip.

METTLER TOLEDO's InPro 5500 i in-line CO₂ sensor includes solutions for both possible failures. A control algorithm for the typical signal curve as shown in Fig. 4 is applied in the background of the InPro 5500 i's software to detect abnormal operating conditions. As soon as an air purge failure or an initial membrane integrity loss is detected, the measurement system issues an alarm and informs plant operators of the possible cause in order that corrective action can be taken. Additionally, the control of a characteristic electrical current drop across the TC chip is used to detect increasing humidity in the gas compartment, which is an early indicator of membrane failure. In cases where the malfunction cannot be immediately rectified, the TC sensing element shuts off automatically for its protection. Consequently, costly damage and/or longer service times are avoided. The algorithms implemented for purge gas monitoring and sensor membrane integrity are elements of METTLER TOLEDO's Intelligent Sensor Management (ISM)

concept, which provides operators with efficient tools for predicting maintenance and easier sensor handling.

Conclusion

In-line dissolved CO₂ monitoring systems for beverage production are important in certain processes. The operational reliability of systems based on thermal conductivity measurement is dependent on the purge gas supply and performance of the gas-permeable membrane. For process engineers who want to increase operational uptime and for quality assurance managers who look for consistent product characteristics, METTLER TOLEDO offers the InPro 5500 i dissolved CO₂ sensor. ISM predictive diagnostics provide a unique and reliable solution to the detection of insufficient purge gas flow or a drop in CO₂ membrane integrity. Early alarms help operators to take appropriate, rapid action to minimize unscheduled downtime and safeguard product quality.



The InPro 5500 i dissolved CO₂ sensor is available with different process connections

Optical Oxygen Measurement with ISM

A Unique Concept for Reduced Maintenance

Optical technology offers significant advantages in highly demanding applications: lower drift, minimal flow dependence, and less and easier maintenance. The unique combination of optical technology with the Intelligent Sensor Management (ISM) concept, opens a new level of safety and ease of use.

Advantages of optical technology

The optical oxygen sensor InPro 6970i from METTLER TOLEDO is designed to fulfill the highest requirements for accurate measurement of low dissolved oxygen levels in breweries. A low detection limit and a fast response to changes in the oxygen value are the key demands, especially in filling lines. The unique combination of optical technology with METTLER TOLEDO's ISM concept has led to a highly efficient, low maintenance, oxygen measurement system.

Trouble-free handling for greater reliability

Oxygen measurement in filling lines requires instruments with high accuracy at low oxygen levels. Filling lines run more or less continuously. Interruptions of the filling process are very short, e.g., during a change of the product or cleaning of the plant. Consequently, the time available for sensor maintenance is brief, and unscheduled downtime is very costly.

An optical oxygen measurement system based on the InPro 6970i, is characterized by its ease of maintenance. Instead of a membrane body, inner body and electrolyte that all require maintenance, there is only one component, the OptoCap, that has to be replaced periodically as a consumable. Due to easy and hassle-free replacement and speed of calibration, the system is ready for measurement in under a minute. Alternatively, sensors pre-calibrated using METTLER TOLEDO's iSense software can be mounted to the process and a correct oxygen reading is available immediately.



OptoCap replacement



After calibration, the operational availability of the system is displayed on an M400 series transmitter.

The long lifetime of the OptoCap, together with the fast and easy replacement, reduces maintenance cost and risk of operating errors.

Plug and Measure for highest availability

All sensor data, including calibration data, is stored on a microchip in the sensor head. This allows maintenance and calibration to be conducted in the controlled and clean conditions of a laboratory. This is especially important for a zero point calibration with oxygen-free gas. Having a gas supply and a gas-tight calibration station in a laboratory is more convenient than taking these items into the production area.

Installation of the calibrated sensor into the process is very simple: After connecting the sensor to the transmitter, all relevant data is automatically uploaded from the sensor and an oxygen reading is available in less than a minute. No pre-polarization is necessary. The InPro 6970i optical sensor helps you to focus on the most important thing, the process itself.

Reduced maintenance

Unscheduled downtime of a filling line caused by a sensor malfunction is time consuming and costly. The reliability and stability of sensors is therefore a critical factor. Consequently, it is important to have reliable information regarding the sensor before starting the process. This is the only way to prevent unwanted process stops. Optical oxygen sensors from METTLER TOLEDO offer valuable information for maintenance planning.

To maximize measurement system reliability, METTLER TOLEDO has developed an advanced diagnostics tool: the Dynamic Lifetime Indicator (DLI). This feature measures the quality of the OptoCap after each calibration and offers data on its remaining reliable lifetime and accuracy of the system: a significant advantage for higher process safety. The highest moments of stress for an optical oxygen sensor are during CIP cycles. Normally, the user has to record each sensor's exposure to CIP, but thanks to ISM technology, the InPro 6970i detects CIP cycles automatically and the number of cycles is stored in the sensor memory. The user is able to predefine a maximum number of CIP cycles for each unit. The measurement system automatically recognizes if this limit is reached and generates a maintenance request. As a result, any unforeseen failure of a sensor is very unlikely. There is no need for manual documentation of the CIP cycles for each sensor: the information is always available in the sensor and can be displayed on the transmitter.

Highest sensor performance in low oxygen applications

In the filling line of breweries, very low dissolved oxygen levels have to be measured accurately, and the detection of changing oxygen levels must be very fast to prevent filling from out-of-spec beer. It was the requirement from breweries for beers with increasingly longer shelf life that led METTLER TOLEDO to develop the InPro 6970i.

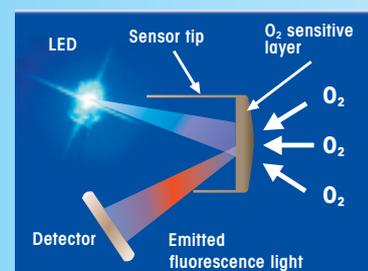
Excellent signal stability and low drift reduce the need for recalibration. The fast response time enables the user to start the filling process much more quickly after a switch from rinsing water to beer, and consequently, possible beer losses are reduced.

Most of the in-line dissolved oxygen sensors available suffer from a stop-of-flow effect. When the filling line is stopped, the resulting increased oxygen reading from the sensor is often the cause of false alarms in the process control system. With an optical oxygen measurement system, the stop-of-flow effect is negligible.

In addition to the faster response time, reliability and process safety are also improved. The risk of errors caused by the sensing element is much less likely. The quality of the OptoCap changes very slowly and failure such as membrane cracks or electrolyte leakage into the beer caused by extreme process conditions (e.g., pressure shocks) is not possible.

Principle of optical oxygen measurement

The heart of the optical sensor is an oxygen sensitive layer containing immobilized molecules. They absorb light from a light emitting diode and are able to release this energy as light at a different wavelength (fluorescence). The fluorescence depends on the amount of oxygen that is present in the environment of the marker molecules.



This effect allows determination of the oxygen concentration in the sample media.

Better Beer, More Beer

Improved Productivity at Tsingtao Brewery

For China's largest brewer, controlling dissolved oxygen levels in beer is vital for ensuring product quality and production volume. Optical measurement technology has not only delivered excellent results, it has also reduced maintenance.

China's largest brewer

Founded in 1903 by German settlers, the Tsingtao Brewery is the largest and most prestigious of the approximately 600 breweries currently operating in China.

One of Tsingtao's key production units out of its 48 facilities is located in Qingdao, in the province of Shandong. In operation since 1991, the recent introduction of modern production equipment from Germany and France means the unit is now highly automated, operates with advanced control methods, and has the capacity to produce up to 450 million liters of beer annually.

DO detection

To a great extent, the quality of beer is associated with the quantity of dissolved oxygen (DO) it contains. Oxygen reacts with proteins and polyphenols in the beer which leads to non-biological instability resulting in reduced shelf life and adversely affected flavor. Consequently, control of DO levels during beer production is always a quality target that Tsingtao focuses on. During production, a significant proportion of dissolved oxygen comes from the filtering process. Therefore, before product enters bright beer tanks, in-line detection of DO prevents out-of-spec beer reaching the filling line.

Since 2003, the brewery has employed METTLER TOLEDO in-line DO measurement equipment at fermentation tanks and filters as well as on other brewery processes. As production at the brewery has increased, CIP cycles have become a significant daily operation. To prevent damage to DO sensor membranes from chemicals and high temperatures, the probes have to be withdrawn from the process pipes during CIP and subsequently reinserted. All of which is time consuming for operators. Could METTLER TOLEDO provide a solution?



Optical technology

We suggested a switch from an amperometric measurement system to one based on optical technology. Our InPro 6970i optical DO sensor exploits the phenomenon of fluorescence quenching to determine trace oxygen levels. No membrane is involved and the sensor is largely unaffected by CIP processes.

But resistance to CIP is not the only benefit of the InPro 6970i: Amperometric sensors are liable to incorrectly report high DO levels if flow velocity is too low. The InPro 6970i has a negligible flow velocity requirement, so false DO level alarms are eliminated. Fluorescence

quenching technology determines oxygen in liquids very quickly; therefore, the response time of the sensor is extremely fast. Additionally, the InPro 6970 i detects DO levels down to 2 ppb. Combined, this means the sensor is an excellent tool for reducing out-of-spec production.

Less maintenance

Tsingtao Brewery also appreciates the reduced maintenance benefits the InPro 6970 i brings. Firstly, sensor drift is very low, so calibration is required less frequently than for amperometric probes. Secondly, whereas maintenance on amperometric sensors involves changing membrane and electrolyte, with the InPro 6970 i the only part that requires periodic replacement is the OptoCap oxygen sensing element. OptoCap exchange is simple and can be completed in under a minute.

The “i” in InPro 6970 i denotes that the probe features METTLER TOLEDO’s Intelligent Sensor Management (ISM) technology. ISM brings additional, maintenance benefits that help sustain Tsingtao’s round-the-clock production. Advanced sensor diagnostics tools displayed on the connected transmitter provide real-time



Bottling line at Tsingtao Brewery

data on the probe’s condition. The remaining lifetime of the OptoCap and when calibration will next be required, as shown by the Dynamic Lifetime Indicator and Adaptive Calibration Timer, mean that maintenance planning is easy and the risk of sensor failure during production is greatly reduced.

Productivity

According to Du Shuhai, an engineer at the brewery, “On the basis of production exceeding 430 million liters in 2009, the successful application of the InPro 6970 i meant that the dissolved oxygen index of all filtered beer was maintained below 50 ppb, and both beer quality and output were improved.”



InPro 6970 i dissolved oxygen sensor

Conductivity for Media Separation Control in Beer Filling Machines

In some processes in the Food and Beverage industry, conductivity is measured to control the separation of two liquids with different conductivity values. One example is the measurement of conductivity of beer and water in the beer filling machine.

Benefits

By using conductivity measurement systems, manual control of media separation by using a sight glass is avoided and the process can be automated resulting in a minimal loss of product, reduced labor cost and increased process safety and reliability.

Process

The beer filling process is based on a CO₂ atmosphere with a pressure of up to 6 bars that pushes the product (beer) to the bottle. During the CIP process, cleaning solution and water is circulated in the machine and in the pipes that bring beer from the production area to the filling line. By the time that the final CIP rinse cycle ends, the pipes and filling machine are completely filled with water.

When production starts again, filling must wait until water has cleared the system and the first filled bottles are sent for lab analysis to determine which bottles will be separated and which have the correct

Typical process conditions:

Media:	water, beer
Pressure:	upto 6 bar
Temperature:	- 2 ... 25 °C
Conductivity range:	beer approx. 1500 [μ S/cm], water approx. 100...150 [μ S/cm]

concentration of beer (no water contamination) to go to the market. Setting the waiting time too short results in a loss of bottles/cans. If the time is set too



long, good beer will be sent to the drain. Sometimes, an operator goes to the drain pipe to determine by color the correct moment when the water ends and the beer starts. An operation that is subject to human error.

The use of a conductivity system to control the exact phase separation between water and beer, and to ensure the correct time to start filling, results in a fully automated process with minimized loss of bottles/cans and beer, and reduced labor cost.

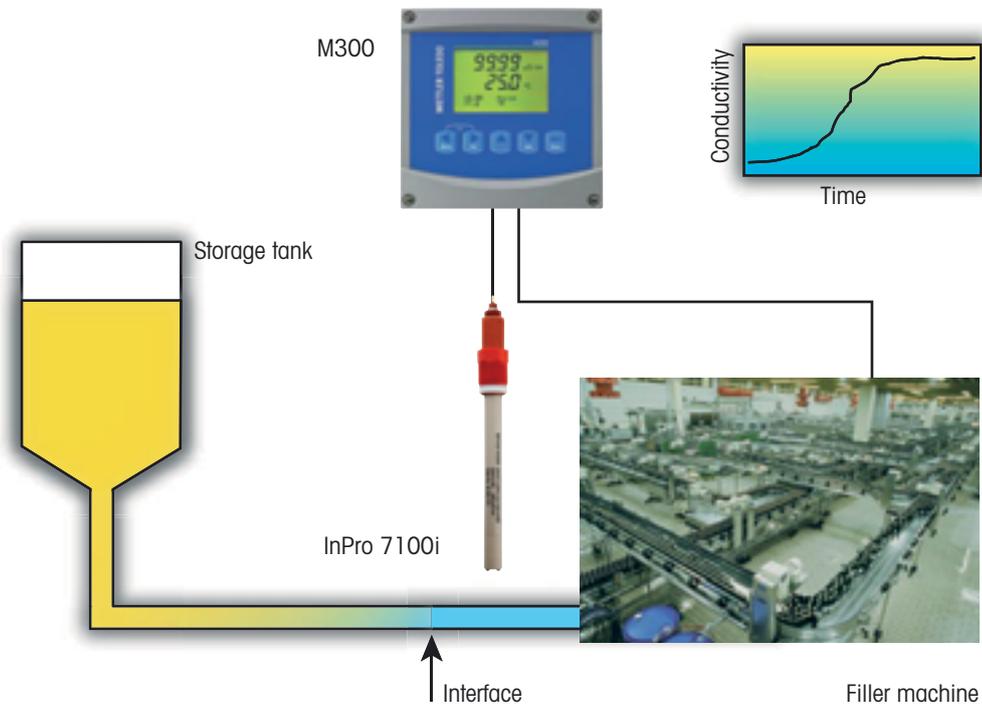


Fig. 1: METTLER TOLEDO measurement loop

METTLER TOLEDO solution

The recommended system for this application consists of an M300 transmitter with an InPro 7100i conductivity sensor installed in the pipe that feeds the filling machine (see Fig. 1).

- Conductivity sensor InPro 7100i
 - Intelligent Sensor Management (ISM)

ISM provides Plug and Measure installation for fast, error-free start up, and robust digital sensor to transmitter communication.
 - Precise phase detection

The 4-electrode InPro 7100i sensor detects the switch from water to beer very quickly and precisely due to a fast response time to both conductivity and temperature.

- Instantaneous response

4-electrode conductivity systems have a response time in the range of seconds. The sensor has to be installed upstream of the valve.
- Minimization of media loss

With fast and precise phase detection, the loss of beer and water in the installation can be significantly reduced.
- Conductivity transmitter M300

The M300 transmitter series combines robustness with ease of use. High versatility and reliability make this instrument the ideal choice for basic process applications. The M300 is available as a single- or dual-channel unit with an attractive price/performance ratio.



InPro 7100i conductivity sensor



M300 transmitter

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