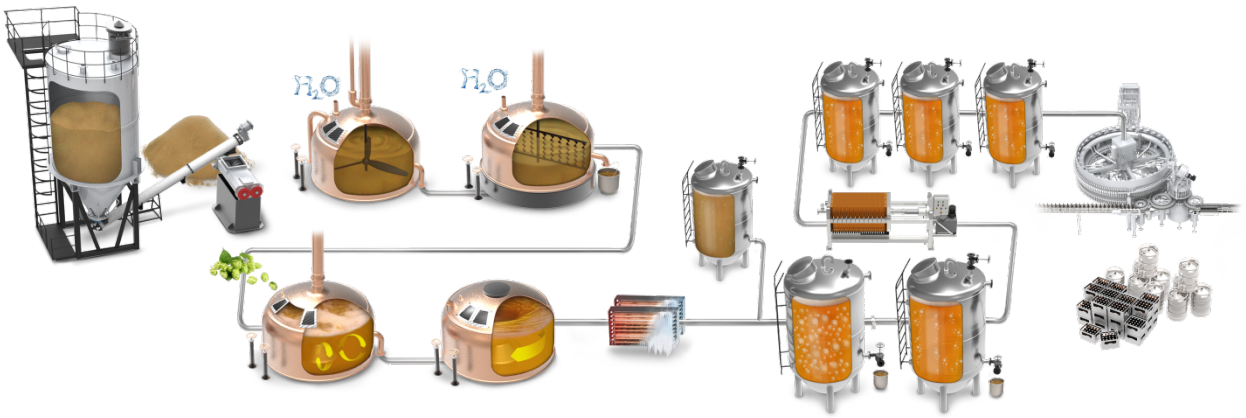
Complete your beer analysis

Relevant for: Breweries, producers and bottlers of beer or related products

Anton Paar is the world's first full-range supplier for beverage analyses who links laboratory and process instrumentation to offer complete and customized measurement solutions.

High-end technology meets global service for the perfect beverage analysis – from incoming raw materials to readily bottled products for continuous consumer satisfaction.



Linking laboratory and process instrumentation means complete and customized solutions, from incoming raw materials to ready-for-delivery final products. This allows easy and fast instrument connectivity and calibration at the push of a button. The entire production can be monitored from any location in the plant, multiple parameters can be traced. Out-of spec production can be reduced, product and company reputation are ensured.

There are more than 20 industry specific instruments to choose from for the individual combination of laboratory and process instrumentation to perfectly fit any production requirement.

High-end technology meets global service for the perfect beer analysis - the perfect match!

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1 Raw material monitoring: mash analysis

Figure 1: Good products ask for good raw materials

Any successful brewing process starts with high-quality starting materials. Having a close look at the ingredients at this early stage is essential for superb beer.

Here is where the challenges start

As stated in the “Reinheitsgebot”, beer is made from water, grain, hops and yeast. While this holds true for Germany and many breweries around the world, beer can also be made with rice, corn, or sugar adjuncts. Specialty beers may also contain creative additions such as juniper, chocolate, chili or other non-standard ingredients to make beers a true delicacy.

The most important feature of malt is its behavior during the mashing process. The congress mash procedure is used to create standardized wort samples which undergo laboratory tests. Both the European Brewery Convention (EBC) and American Society of Brewing Chemists (ASBC) have standard methods to measure the most important criteria of congress wort.

Do not miss out to get the picture!

Measuring relevant parameters with Anton Paar instruments helps ensure that only the best raw materials find their way into the brewing kettle!

Density and pH measurements show how well the malt performs during the mash. Mash pH impacts enzyme activity. Mash extract, derived from its density, is a measure of enzyme activity and the amount of fermentable sugars produced. Mash extract is a quality and enzyme efficiency indicator.

Wort viscosity directly correlates with the degree of modification. It provides information on malt solubility, expected lauter time, beer filterability, foam stability, taste and influences product quality and process efficiency.

Sample preparation with **microwave digestion systems** followed by trace analysis allows you to verify the quality of the raw material and to gain information on trace impurities of toxic elements by acid digestion.

Only the best raw materials find their way into the brewing kettle!

- Optimization of the production process
- High-quality end products
- Required actions possible in time
- Time and cost effectiveness ensured

Complete your beer analysis!

Parameters and lab instruments:

Density (Extract): DMA 4100/4500/5000 M benchtop density meter

pH: pH ME / pH ME beverage measuring module for DMA M

Viscosity: Lovis 2000 M/ME microviscometer

Multiparameter measurements:
DMA M; Lovis 2000 ME; pH ME; Xsample 320/520

Sample preparation: Multiwave microwave reaction system

Figure 2:
left: DMA 4100/4500/5000 M benchtop density meter;
right: DMA 4500 M and pH ME

2 Wort monitoring: lauter tun and mash filter

Figure 3: Monitoring at an early stage

Monitoring the lautering process ensures optimum progression of the brewing process. The thorough separation of wort and spent grain by lautering is the key to product quality, process control and extraction efficiency.

Extract the best, leave the rest

After mashing, liquid and solid matter are separated in the lauter tun, the grain's husk forming the filter bed. Instead of the lauter tun, some breweries use mash filters. Regardless of lauter tun or mash filter, the resulting filtrate, wort, is the essence of the final product.

Wort quality and concentration are key parameters worth watching as they indicate how well the grain converted during mashing. It is vital to keep track of the wort's concentration during the entire run-off, especially while sparging. The concentration continues to drop as residual extract is rinsed from the malt grist. Continuously monitoring the wort enables the highest possible extract yield in the kettle, reducing water usage and extract loss.

Clear wort without any particles that could have negative effects on filterability and foam stability later in the brewing process is an indicator for a successfully accomplished lautering operation.

Good runnings

Monitoring the lauter tun and mash filter effluents allows the brewer to optimize lauter tun efficiency, to better determine when to send first runnings to the kettle, and when to send last runnings to waste.

Concentration measurement of the wort allows instant knowledge of the total extract mass. Knowledge of the total average extract concentration is an important source of information for the following step in the brewing process.

Density (Extract, °Plato, SG) measurements save water, lower the wastewater volume and load, reduce the boil time, reduce extract loss and improve the overall brewhouse efficiency.

Monitoring lautering pays off!

- Considerable energy savings achieved
- Substantial time savings
- Minimized extract losses
- Stable brewhouse operations ensured

Complete your beer analysis!

Parameter and lab instruments:

Density (Extract): DMA 35 portable density meter; DMA 4100/4500/5000 M benchtop density meter

Online/inline instruments:

Extract/Plato Monitor: L-Dens 7400/7500 density sensor; L-Sonic 5100 sound velocity sensor; L-Rix 5200 inline refractometer

Software: Davis 5 Data Acquisition and Visualization Software (incl. mPDS 5 evaluation unit)

Figure 4:
left: DMA 35 portable density meter;
right: L-Dens 7400 density sensor

3 Wort monitoring: kettle

Figure 5: Monitoring wort in the kettle

The kettle is the heart of a brewery. Paying special attention to the boil by measuring relevant parameters means treading the path that leads to optimum product quality.

Where the essence develops

Wort is boiled in the kettle. Hops are added for aroma, flavor, and stability. During the boiling process, various chemical and technical reactions take place, including sterilization of the wort. Hop oils are isomerized, releasing their flavors and aromas. The boil on average lasts between 45 and 90 minutes, depending on its intensity, the hop addition schedule, and volume of water expected to evaporate.

During evaporation, undesired volatile aromas are removed. The volume decreases through evaporation, thus dictating the original extract. As a consequence, the desired product characteristics and even legal requirements are ensured.

At the end of the boil, the hopped wort is transferred to a whirlpool, where solid particles such as hops and coagulated proteins are held back.

Culinary beer art

Monitoring of the kettle extract, via density or sound velocity, can increase output quality and quantity.

Density (Extract, °Plato, SG) measurement, be it at the kettle, the external boiler, or the whirlpool, optimizes the boiling efficiency, saves energy, reduces the boiling time and influences the overall brewhouse efficiency.

pH measurement informs about yeast metabolism.

To boil with care

- Reduced boil time
- Considerable energy savings
- Increased brewhouse efficiency
- Correct course of the brewing process

Complete your beer analysis!

Parameters and lab instruments:

Density (Extract): DMA 35 portable density meter; DMA 4100/4500/5000 M benchtop density meter

pH: pH ME / pH ME beverage measuring module for DMA M

Multiparameter measurements:
DMA M; pH ME; Xsample 320/520

Online/inline instruments:

Extract/Plato Monitor: L-Dens 7400/7500 density sensor; L-Sonic 5100 sound velocity sensor

Software: Davis 5 Data Acquisition and Visualization Software (incl. mPDS 5 evaluation unit)

Figure 6:
left: DMA 35 portable density meter;
right: L-Dens 7400 density sensor

4 Wort monitoring: whirlpool

Figure 7: Monitoring wort in the whirlpool

After the boil, the kettle is full of wort and trub from the hops. The trub is removed in the whirlpool to obtain clear wort for further successful brewing.

Give wort a whirl

Hops, added as pellets or entire flowers to the kettle, release aroma compounds during the boil. Once the soluble hop compounds have been brought into solution in the kettle, some insoluble hop components remain which may inhibit subsequent brewing steps and are therefore removed. This is done by swirling either in the kettle itself or, better, in a whirlpool.

A separate whirlpool allows an overall faster brewing process.

After boiling, the wort is transferred tangentially to the whirlpool with high speed. Due to the rotational movement, the separation starts: the heavier particles move to the center and sink to the bottom of the vessel. The whirlpool rest should be as short as possible to avoid thermal stress of the wort, which guarantees lighter color and improved flavor stability of wort and beer, conserving aromas and minimizing steam losses at the same time.

The brewing progress in plain view

Density and turbidity play an important role: if considerable amounts of trub reach the fermentation, a raspy bitterness can result.

Density (Extract, °Plato, SG) measurement before or after the whirlpool optimizes the separation efficiency of wort from trub, reduces brew time, and influences the overall brewhouse efficiency. If high gravity brewing is practiced, sugar syrup may be added before or after the whirlpool. Inline extract monitoring can ensure proper concentration and blending.

Turbidity measurement helps ensure that a clear wort is obtained after the whirlpool.

pH measurements help ensure that the progress takes its proper course.

Beer color not only appeals to the consumer's eye but also informs about the correct composition of the product.

Get a clear view of the brewing process

- Clear wort without unwanted trub particles
- Optimized yield of clear wort
- Increased efficiency achieved
- Time, energy and cost effective

Complete your beer analysis!

Parameters and lab instruments:

Density (Extract): DMA 35 portable density meter; DMA 4100/4500/5000 M benchtop density meter

Color: Alcolyzer Beer M alcohol meter with color option

Turbidity: HazeQC ME turbidity measuring module for DMA M

pH: pH ME / pH ME beverage measuring module for DMA M

Alcolyzer Beer Analyzing System: DMA M; Alcolyzer Beer ME with color option; HazeQC ME; pH ME; Xsample 320/520

Parameters and online/inline instruments:

Extract/Plato Monitor: L-Dens 7400/7500 density sensor; L-Sonic 5100 sound velocity sensor; L-Rix 5200 inline refractometer

Color: L-Col 6100 photometer

Software: Davis 5 Data Acquisition and Visualization Software (incl. mPDS 5 evaluation unit)

Figure 8: left: DMA M with Alcolyzer Beer ME, pH ME, HazeQC ME and Xsample 520;
right: L-Dens 7400/7500 density sensor

5 Wort monitoring: wort cooler

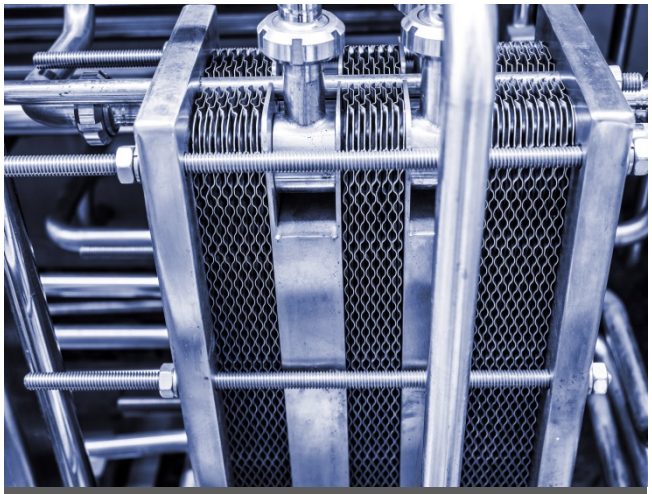


Figure 9: Monitoring wort in the wort cooler

The clear wort is cooled down from boiling hot to a temperature roughly between 5 °C and 20 °C, depending on the beer style. Then the yeast is added.

When in a brewery, do as the brewers do

After the whirlpool, the wort is cooled to fermentation temperatures using a heat exchanger before yeast is added. The actual temperature depends on the beer style and yeast strain. Cold wort is a common application in Europe and Asia, especially in Germany, Austria and Japan. In these countries, beer is partially legislated under food (not alcohol) tax code which means that breweries are taxed based on the extract used and not the alcohol produced. Thus, the extract concentration and total extract mass of cold wort are important.

In case of high gravity brewing, the wort concentration lies typically between 14° Plato and 20° Plato, sometimes as high as 30° Plato. More fermentable sugars means that a higher-alcohol mother beer can be produced that is diluted later in the process with de-aerated water which is mostly done by larger breweries worldwide.

Clear wort? That is cool!

By continuous monitoring of the extract by density or sound velocity measurements, product quality specifications are determined and maintained.

Density (Extract, °Plato, SG) measurements save water, lower the waste water volume, reduce the boiling time and influence the overall brewhouse efficiency.

Sound Velocity (Extract) can be used to determine the concentration of the wort.

Dissolved oxygen measurement is used to ensure proper yeast health and activity in the fermenter.

Beer color not only appeals to the consumer's eye but also informs about the correct composition of the product.

Straight ahead to first place

- Maximized efficiency
- Conscious use of energy
- Time and cost savings
- The direct route to great beer

Complete your beer analysis!

Parameters and online/inline instruments:

Extract/Plato monitor:
L-Dens 7400/7500 density sensor; Oxy 5100 dissolved oxygen sensor; L-Sonic 5100 sound velocity sensor

Color: L-Col 6100 photometer

Software: Davis 5 Data Acquisition and Visualization Software (incl. mPDS 5 evaluation unit)

Figure 10:
left: L-Sonic 5100 sound velocity sensor;
right: The Davis 5 Data Acquisition and Visualization Software

6 Fermentation monitoring

Figure 11: Monitoring during fermentation

In the fermenter, major changes are underway as the yeast converts sugar into alcohol and carbon dioxide and the so far alcohol-free liquid is turned into beer.

This evolution deserves special attention.

The beer starts here

Once yeast is added to the aerated cold wort and all the oxygen is metabolized by the yeast, fermentation starts. The conversion of carbohydrates to alcohol and carbon dioxide is arguably the most important part.

What's created here can finally be called “BEER”.

Careful monitoring is the mother of a good beer

Certain brewing methods such as high-gravity brewing require additives for increasing the yeast activity; in such cases a concentration measurement by density proves useful.

Laboratory density measurement and inline refractive index monitoring (extract, SG, apparent extract) allow keeping the overall fermentation curve and speed and enable more proactive production planning.

Oxygen determination is essential to make sure that the added yeast has enough air for optimum performance.

pH measurements during fermentation are helpful to ensure consistent product quality and taste and allow for prior planning of batch blending.

It is worth the attention

- Excellent yeast performance maximizes the yield
- Optimized fermentation progress ensured
- Consistently high product quality achieved
- Timely action possible to achieve the desired output

Complete your beer analysis!

Parameters, lab and At-line instruments:

Density (Extract): DMA 35 portable density meter; Alex 500 Alcohol and Extract meter;
DMA 4100/4500/5000 M benchtop density meter

Dissolved oxygen: OxyQC wide range portable oxygen meter

pH: pH ME / pH ME beverage measuring module for DMA M

Alcolyzer Beer Analyzing System: DMA M; Alcolyzer Beer ME w/wo color option; pH ME; Xsample 320/520

Parameter and online/inline instruments:

Fermentation: Fermentation monitor 5100

Software: Davis 5 Data Acquisition and Visualization Software (incl. mPDS 5 evaluation unit)

Figure 12:
left: DMA M benchtop density meter;
right: Fermentation monitor 5100

7 Beer monitoring: filtration

Figure 13: Monitoring the beer during filtration

After fermentation, the newly brewed beer is filtered. Only the desired components pass: clear, high-quality beer.

A cheer for clear beer!

Filtration can be carried out in different ways: it can be rough, leaving some cloudiness in the beer, fine, removing all the cloudiness for a meticulously clear beer, or sterile, ensuring all microorganisms are removed.

Filtration is not only performed to obtain a clearer or completely clear beer without any suspended particles in it, but also to stabilize the beer by removing any substances that might cause unwanted turbidity. In most cases, Kieselguhr (diatomaceous earth) is used as a filter material.

Beer backstage

The measurement of all quality parameters is crucial during this production phase: Here is the last opportunity where these parameters can be measured and modified!

The accurate measurement of **alcohol, extract, CO_2, O_2, color, pH and turbidity** in beer provides an immediate, significant insight into product quality, consistency and production efficiency, whether in high-gravity blending, carbonation or blending. Before filtration, the measurements are carried out in the laboratory from the lager tanks whereas inline measurements are often found pre-installed on larger blending or filter systems. The viscosity of beer provides information on the beer's filterability.

Inline instrumentation is also easily added to an existing system and provides valuable information during the filtration process. The beer monitor for inline installations offers itself as the ideal solution for comprehensive monitoring of relevant quality parameters.

Beer color not only appeals to the consumer's eye but also informs about the correct composition of the product.

Accurate measurements stand for quality

- Consistently high beer quality
- Only product that meets the specifications released for bottling
- Timely action possible for desired output quality
- Optimized efficiency during the entire brewing process

Complete your beer analysis!

Parameters, lab and At-line instruments:

Density (Extract), Alcohol: Alex 500 Alcohol and Extract Meter

Alcohol/Color: Alcolyzer Beer M alcohol meter w/wo color option

Dissolved CO_2, O_2: CarboQC/CarboQC At-line CO_2 meter; OxyQC O_2 meter; CboxQC/CboxQC At-line CO_2 and O_2 meter

Multiparameter measurements: DMA M; Alcolyzer Beer ME w/wo color option; HazeQC ME; pH ME; Lovis 2000 ME microviscometer; Xsample 320/520

Parameters and online/inline instruments:

Beer monitor: Beer Monitor 5500/5600; L-Com 5500 density and sound velocity sensor; Carbo 5100, Carbo 6100/6300 inline CO_2 sensors; Oxy 5100 dissolved O_2 sensor

Color: L-Col 6100 photometer

Software: Davis 5 Data Acquisition and Visualization Software (incl. mPDS 5 evaluation unit)

Figure 14: left: Alex 500 Alcohol and Extract meter; right: Oxy 5100 dissolved oxygen sensor

8 Beer monitoring: storage

Figure 15: Monitoring beer during storage

Depending on its style, the beer is left 3 weeks to 3 months in lager tanks, where its flavor and characteristics develop. However, corrections are - if accurate measurements show deviations - still possible.

Give taste a chance

Accurate measurements of alcohol, extract, CO_2, O_2, color, pH and turbidity need to be performed to check product specifications before the product is packaged. Whether high gravity brewing, fine tuning or blending, the accurate measurement of these parameters can provide an immediate, significant improvement to product quality, consistency and production efficiency.

The bright beer tank is the last step in the beer production where these parameters can be measured and still modified before the product is bottled or canned. It is therefore a matter of course that comprehensive investigation of the beer at that stage is essential.

Playing it safe

Do not miss the opportunities offered by powerful measuring instruments! Your beer's quality depends on it.

Alcohol measurement confirms whether the alcohol concentration meets the specifications.

Dissolved oxygen measurement is a must: any oxygen in the beer reduces the shelf life and can have detrimental effects on taste and color.

Dissolved carbon dioxide determination ensures carbonation levels are up to specifications, thus fulfilling taste requirements.

Color and turbidity measurements ensure the beer fulfills quality standards and appeals to what meets the eye.

pH measurements allow monitoring consistent product quality.

If it's on the label, it's in the beer

- Continuous consumer satisfaction
- Consistent product quality
- Timely action possible to achieve the desired product specifications
- Label requirements safeguarded

Complete your beer analysis!

Parameters, lab and At-line instruments:

Alcohol/Color: Alcolyzer Beer M alcohol meter w/wo color option

Turbidity: HazeQC ME turbidity measuring module for DMA M

Dissolved CO_2, O_2: CarboQC/CarboQC At-line portable CO_2 meter; CboxQC/CboxQC At-line portable CO_2 and O_2 meter; OxyQC portable oxygen meter

pH: pH ME / pH ME beverage measuring module for DMA M

Alcolyzer Beer Analyzing System: DMA M; Alcolyzer Beer ME w/wo color option; HazeQC ME; pH ME; Xsample 320/520

Figure 16: left: CboxQC At-line CO_2 and O_2 meter; right: DMA M with Alcolyzer Beer ME, pH ME, HazeQC ME and Xsample 520

9 Beer monitoring: pre-filler and packaging

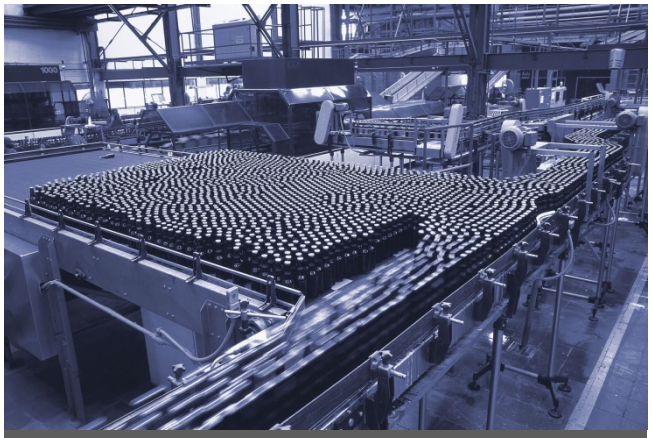


Figure 17: Last checks on the finished beer

Final quality control before the product leaves the plant for the last check on the specifications guarantees continuous consumer satisfaction.

Consistent beer quality

Final product quality is what the consumers see, taste and experience every time a package is opened. This is the last and final spot check of the packaged product before it leaves the plant and ensures that only the best product is delivered to be consumed.

Modern instrumentation allows analyses in a very quick measurement time and ensures that all specifications and legal requirements are met thus increasing overall production efficiency until the very end of the entire beer production process.

Beer blending

Careful monitoring of the packaged product before delivery puts the brewers' mind at rest: these measurements assure that only high-quality product is delivered to its final destination. Powerful instrumentation helps: some instruments have already accompanied the beer during the entire production process right from the start.

Dissolved oxygen measurement is a must in the beer as well as in the head space: any oxygen in the beer reduces the shelf life and can have detrimental effects on taste and color.

Dissolved carbon dioxide determination ensures carbonation levels are up to specifications, thus fulfilling taste requirements.

Alcohol measurement confirms whether the alcohol concentration meets the specifications.

Color and turbidity measurements ensure the beer fulfills quality standards and appeals to what meets the eye.

pH measurements allow monitoring consistent product quality.

The beginning of a long friendship

- Label specifications and legal requirements fulfilled
- The beer keeps what the label promises
- The same instruments can accompany the entire production process
- Constant quality keeps consumers happy

Complete your beer analysis!

Parameters, lab and At-line instruments:

Dissolved CO_2, O_2: CarboQC/CarboQC At-line portable CO_2 meter; CboxQC/CboxQC At-line portable CO_2 and O_2 meter; OxyQC portable oxygen meter; TPO 5000 Total Package Oxygen meter

Alcohol, extract, color, turbidity, pH, CO_2 and O_2: Packaged Beverage Analyzer (PBA-B) M (DMA 4500/5000 M; Alcolyzer Beer ME w/wo color option; CarboQC ME w/wo Option O_2 (Plus); HazeQC ME; pH ME; PFD/PFD Plus Filling Device)

Parameters and online/inline instruments:

Beer monitor: Beer Monitor 5500/5600; L-Com 5500 density and sound velocity sensor; Carbo 5100, Carbo 6100/6300 inline CO_2 sensors; Oxy 5100 dissolved O_2 sensor; Color/Turbidity options

Color: L-Col 6100 photometer

Software: Davis 5 Data Acquisition and Visualization Software (incl. mPDS 5 evaluation unit)

Figure 18: left: PBA-B M; right: Beer Monitor 5500

10 Skid-mounted Beer Analysis Systems

Figure 19: Beer Analysis System ready for integration

The increasing capabilities of online analysis and complexity of system integration result in the need for measuring systems delivering all critical quality control parameters in the beer filling line.

The challenge

Stringent quality standards have become standard in modern beer industry.

The aim is all-over quality control which ensures that only products complying with highest quality standards reach the packaging line at the end of the beer production process.

Highly integrated all-in-one solutions are a way to overcome the conflict of this aim with the objective of cost reduction and the limitation of resources.

All-in-one and highly integrated

Available as skid mounted system or as modular system distributed over the existing pipe work the Animo 5100 Beer Analysis System is seamlessly integrated into new and existing filling lines.

The integrated sensors and analyzers are ready to use without time-consuming commissioning and on-site adjustments. Pre-configured in the factory, they come with the right setup and calculation methods for beer analysis.

For upgrading and refurbishing projects the Animo 5100 is an open system, capable of being adapted to existing infrastructure and components provided by the customer.

By providing project engineering, system design, installation support and commissioning Anton Paar makes the all-in-one package complete. Customers benefit from a ready-to-go quality control system.

Efficient projects to productivity

- The short track from site survey to productive quality control
- A central access point to all critical quality parameters
- Zero out-of-spec products in your package line
- No hassle with adjustment and calibration
- Annual maintenance effort of less than a day

Complete your beer analysis!

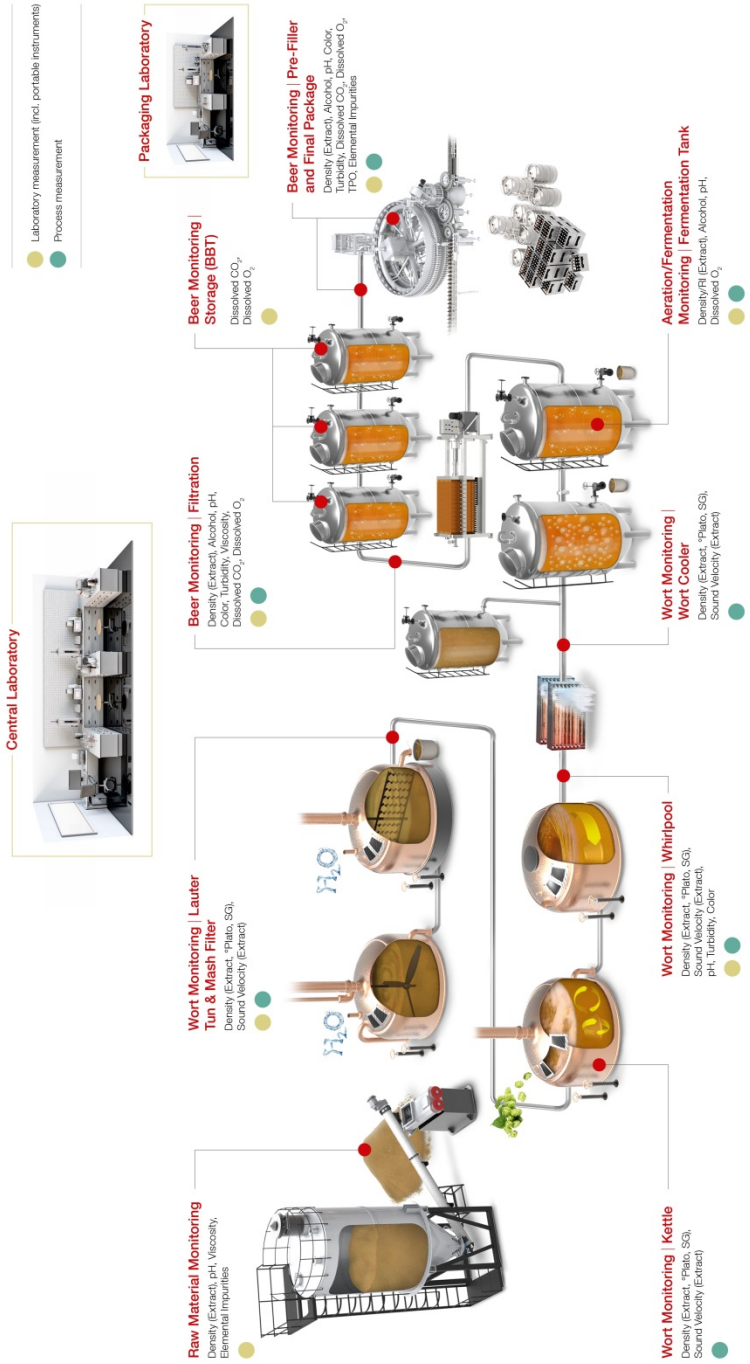
Online/inline systems:

Animo 5100 beer analysis System - integrated instruments:

- L-Com 5500 – alcohol and extract measurement
- Carbo 6100/6300 – dissolved CO_2 measurement
- Oxy 5100 – dissolved oxygen measurement
- Evaluation Unit mPDS 5 – data integration
- Davis 5 software – analysis, calibration, reporting
- Conductivity sensor – detection of CIP agents
- Flow meter
- Piping and wiring - site specific integration
- Option L-Col 6100 photometer
- Extensions on customer request

Figure 20: left: outlet and drain valves; right: sensor section

11 The beer production process – an overview



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