In the kingdom of beer

The largest brewery in Switzerland gets a made-to-measure system

Jules Wyss, head of quality assurance at the Feldschlösschen brewery in Rheinfelden, is thrilled with his new analysis system. According to Jules, the system can reliably measure around 90% of the parameters he needs to determine in beer samples. This solution, which is perfectly tailored to the needs of the brewery's laboratory, is the result of close collaboration between Jules and Jonas Grozinger, his sales adviser at Metrohm.

Feldschlösschen – the largest brewery in Switzerland

On February 8, 1876, Theophil Roniger and Mathias Wüthrich started the first brew in their newly founded brewery in Rheinfelden in the Swiss canton of Argovia. The «Brauerei zum Feldschlösschen» (Feldschlösschen brewery) produced 4,000 hectoliters of beer in its first year. 20 years later, the brewery was the largest beer producer in Switzerland with an output of 100,000 hectoliters. Thanks to its continual growth – output exceeded 1 million hectoliters in 1974 – Feldschlösschen has held onto this title ever since. Along with the volume, the variety has also increased: Feldschlösschen now produces over 40 beers and other beverages such as alcohol-free beers, beer mixes, and soft drinks. Since 2000, Feldschlösschen has been part of the Carlsberg Group, the third-largest brewery group in the world.

Quality assurance in the brewery business

Not only does beer have to meet high standards in terms of its taste as a drink, it also has to comply with quality parameters that can be measured with instruments. At Feldschlösschen, the quality assurance process for beer and its precursors involves determining chemical and physical parameters such as the alcohol and sugar content, the pH value, bitter substances, original wort, and the color of the beer.

50–100 samples of various types are processed every day in the Feldschlösschen quality assurance laboratory. Alongside finished beers and beer mixes, these also include beer wort samples, beers that have been in storage but have not yet been filtered, and samples from the product development process.

Figure 1. Samples in the quality assurance laboratory at the Feldschlösschen brewery

Previous solutions failed

For a long time, Jules determined the quality parameters in his beer samples using separate analysis systems: A titrator, an HPLC system, an alcohol measuring device, and a density meter. These separate measurements involved a huge amount of work: not only the analyses themselves, but also the documentation and archiving of the results all had to be handled separately. Furthermore, Jules often had to contend with unreliable results – depending on the measurement procedure, he had to analyze one sample up to three times in order to obtain an accurate result.

A tailor-made system for Feldschlösschen

Jules' close collaboration with Metrohm has produced a system that takes care of the majority of the necessary measurements. According to Jules, the system can determine around 90% of the parameters he needs to measure. Jules' new analysis system combines various analysis techniques: ion chromatography and titration from Metrohm as well as alcohol, density, and color measurement from another manufacturer. They are all controlled by the tiamo titration software. This means that bitter substances, citric acid, pH value, alcohol content, density, and color can all be determined by executing a single method in tiamo.

Figure 2. Jules Wyss with his analysis system in the quality assurance laboratory at Feldschlösschen in Rheinfelden. The system combines ion chromatography, titration, density measurement, and spectroscopic alcohol determination.

Depending on which parameters need to be measured, the sample preparation generally consists of filtrating, degassing, adding defoamers and, if applicable, dilution. Jules and his colleagues perform these tasks by hand. Once they have placed the samples on the sample changers and started the measuring method, the analysis system takes care of everything – from the sample injection to the measurement and evaluation, right through to archiving all of the results in tiamo.

Robust calibration and rapid deployment

The analysis system increases efficiency in the laboratory and saves the employees in the Feldschlösschen laboratory a great deal of time. This is down to a number of factors – chief among them, of course, the integration of multiple parameters into one system, combined with the robust calibration and the fact that the system is ready to start measuring in next to no time. In the case of both of these factors, the combined analysis system is a significant improvement on the individual solutions that were previously in use. Last but not least, the system's robust operation means that it does not need constant monitoring – at Feldschlösschen, measurement series carry on running through breaks and overnight.

Bitter substances

When we talk about measuring the bitterness of a beer, we are referring to the levels of iso-α-acids and their derivatives in the beer rather than how bitter it tastes when drunk. These substances are formed from the α-acids in the hops during the wort boiling process (Figure 3). The key bitter substances in the beer are the iso-α-acids as well as the tetrahydro-iso-α-acids and rho-iso-α-acids that are derivatives of the iso-α-acids (Figure 4). The levels of bitter substances can vary considerably between beer varieties. Jules and his colleagues at Feldschlösschen use ion chromatography to determine the bitter substances.

Figure 3. The wort is still boiled in copper wort kettles in the Art Nouveau brewhouse which was built in 1909. This process causes the α-acids in the hops to isomerize into iso-α-acids.

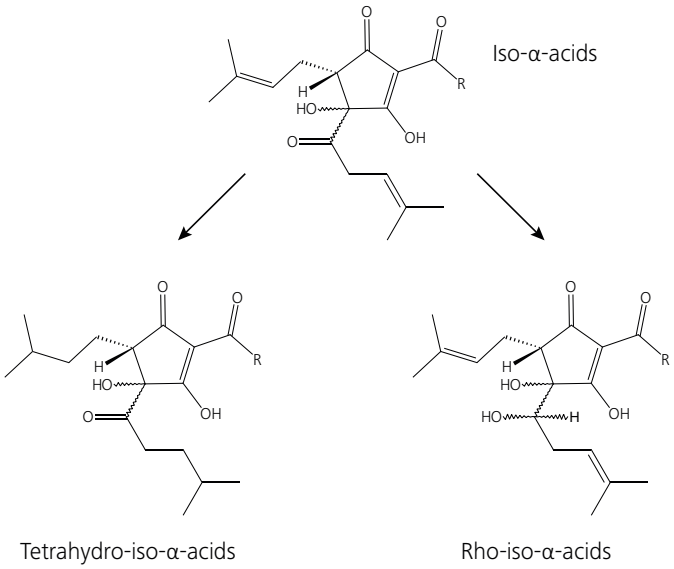

Figure 4. Structures of the iso-α-acids and their derivatives tetrahydro-iso- and rho-iso-α-acids. These three substance groups make up the majority of the bitter substances in beer.

Before the actual chromatographic separation, the sample matrix is removed using a guard column. This eliminates interference and significantly extends the service life of the separation column, an HPLC column with hydrophobic packing: Jules can carry out 1,000 analyses with one column.

The separation column is short, resulting in a low chromatographic resolution, which causes the bitter substances to elute together. This is sufficient for determining the bitterness and offers advantages in the form of low column costs and short analysis times: the results are ready in just eight minutes. The bitter substances are ultimately detected using a UV/VIS detector.

Citric acid and pH value

The process of determining citric acid is primarily relevant to beer mixes. It uses the set endpoint titration (SET) method. The titration is carried out with sodium hydroxide up to a set pH value of 8.1. A pH electrode, the Unitrode from Metrohm, is therefore used as the indicator electrode. The citric acid content is calculated from the volume of sodium hydroxide solution used to reach the endpoint.

Alcohol content and density

The alcohol content and density of the beer are not determined using Metrohm instruments, but the measuring instruments are connected to the Metrohm analysis system. This means that the determination does not need to be carried out separately and the results are archived centrally in tiamo together with those from the Metrohm instruments. The alcohol analyzer is based on near-infrared spectroscopy (NIR). The density is measured using the oscillating U-tube principle: a U-shaped glass tube in the measuring instrument is filled with the sample and made to oscillate. The eigenfrequency depends on the density of the sample. The density can therefore be derived from the oscillation period measured in the density meter.

Results: Evaluation and archiving

The results of the analyses described above are all collected in tiamo. This makes it much easier to manage the data. Reports covering all the different methods save Jules and his colleagues in the Feldschlösschen quality assurance laboratory having to compile the results from multiple databases. This saves time and prevents errors.

Outlook

Jules can now use his integrated system to determine the majority of the parameters he needs to analyze in the samples at Feldschlösschen. Compared to using individual solutions to determine each parameter, this saves a great deal of time and increases efficiency in the quality assurance laboratory. Furthermore, the system is extremely popular among the laboratory personnel because it is easy to use.

Additional parameters such as sulfite and sugar could potentially be integrated in the future and the sample preparation could be automated. This flexibility is an attractive prospect for Feldschlösschen with its large portfolio of different drinks, but would also appeal to other companies in the beverage industry such as winemakers or producers of alcohol-free drinks. For now, Jules is happy with his system, which saves all of the laboratory staff a lot of time and effort: «Not every manufacturer of analysis instruments can offer a customized solution like this one. Metrohm put a lot of hard work into making it a success for us.»

About Jules Wyss

Jules Wyss has been working at Feldschlösschen for over 25 years. The master brewer and beverage technologist helped to set up the quality assurance laboratory from 1991 onward. Today, he is the head of the laboratory. Jules cannot imagine working at a different brewery: thanks to its size and significance within Switzerland, the Feldschlösschen brewery offers more opportunities than smaller breweries. But more than that, it is the connection to the long history of brewing – which is felt more keenly in the castle in Rheinfelden than perhaps anywhere else – that makes working there so special.