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Changes in water supply during climate change

A reliable water supply is the basic prerequisite for producing high-quality beverages. In times of climatic change, this can no longer be taken for granted in many places. In the summary of his presentation from the forum of BrauBeviale 2019, Frederik Amrhein from the Institut Romeis showed that well monitoring and water treatment are now becoming pivotal tasks for breweries and beverage producers.

Secure water supplies can no longer be taken for granted

In recent decades, having a secure water supply has been taken for granted in many companies in Germany. However, the effects of climate change are now leading to an increase in the average annual temperatures in Central Europe, and therefore also in Germany. Longer dry periods, increased precipitation, and the consequences that these have on the hydrological cycle [2] influence groundwater levels and the general availability of water.

Companies are now forced to use this resource more efficiently for ecological and economic reasons – regardless of whether their water supply is publicly or independently managed.

Water consumption at breweries

Beer with a 12% original wort consists of 90–92% water [3]. In breweries, water is not only used as brewing water, but also for cleaning, cooling, pasteurisation, and for internal drinking water supply.

While the average consumption in 2001 was still three litres of water per litre of beer sold (not including water for cooling), it can be much lower in modern breweries today [4].

Water must have certain qualities depending on what its intended use is in the brewery. The water supply of a brewery is either provided by a public water supplier, by a company-owned well, or by a combination of both.

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The German drinking water ordinance (TrinkwV)

In Germany, if a brewery uses the public drinking water supply, the public supplier is responsible for compliance with the requirements of the drinking water ordinance (TrinkwV) at the point of transfer to the brewery. However, it is still recommended for the brewery to check the chemical and biological water quality regularly, as some parameters can change in the company's own distribution network.

If a brewery operates its own well, it is responsible for the quality of the water coming from that well. It also needs to ensure compliance with the drinking water ordinance (TrinkwV) parameters.

Anthropogenic influences

In addition to the chemical, technical and microbiological qualities of the water used, anthropogenic influences (originating from human activity) can also endanger water purity.

Surface water, and also some water from deeper layers underground, can contain pesticide residues and their metabolites, drug residues, fertiliser residues from agriculture (e.g. nitrates), or cleaning and disinfectant residues [5].

Regular, routine monitoring of these quality parameters is part of an effective well monitoring system, and is also required by law.

Well output monitoring

In addition to monitoring the quality parameters above, monitoring is also needed for a well’s performance in order to be able to detect and correct a drop in well output in good time. A drop in output can be caused by deposits in pumps, risers, or filter pipes, silting in filter slots or filter gravel, corrosion of steel components, or slime accumulation [6].

To monitor a well’s performance, the delivery rate, resting level and operating water level all need to be monitored. Furthermore, after delivery, the time it takes for the resting water level to be reached again can provide information about the condition of the well.

Regional influences of water on beer types

Water characteristics have a decisive influence on beer production. In earlier times, local water quality determined the possibilities for which beer types could be produced in a region.

For example, the soft water of the Czech city of Pilsen, with its low residual alkalinity, was ideal for the production of fine, light beers produced using the pilsner brewing method.

The moderately hard water of the city of Munich, with its high residual alkalinity, paved the way for the development of characteristically dark beers [3]. These examples show the decisive influence of regional mineral water composition on the development of local beer types.

Water hardness and residual alkalinity

Water can be characterised by its hardness. For a more comprehensible description, water hardness is divided into total, carbonate, and non-carbonate hardness. Both total hardness and the ratio of carbonate to non-carbonate hardness depend primarily on the geological subsoil structure.
In addition to water hardness, the residual alkalinity according to Kolbach (RA) has a decisive influence on the effervescence-specific properties of water.

Consequently, a residual alkalinity of 0°dH does not influence the pH value of the mash or wort, whereas a residual alkalinity of 10°dH would raise it by 0.3 and a residual alkalinity of -10°dH would lower it by 0.3 [7].

The influence of residual alkalinity is not insignificant, as the pH value of the mash and wort has a great influence on brewery processes, the resulting taste of the beer, and also on foam stability.

Monitoring pollutants

In many breweries and ancillary companies, effective monitoring of pollutants is something that is already firmly established within quality assurance measures. These measures should cover the water being used as a raw material just as much as it concerns other raw materials like malt and hops.

The potential risks of anthropogenic influences are not yet fully reflected in the German drinking water ordinance (TrinkwV). Past experience, coupled with increased consumer interest, is likely to establish the influence of pollutants on beer purity as a pivotal future topic for the industry.

Water treatment

The most modern water treatment plants are in use today in order to minimise the negative influences of excessive water hardness, residual alkalinity and anthropogenic influences on beer quality. These plants can be used to convert water into the desired composition, so that a brewery's location no longer has any influence on the portfolio of beers that it can produce.

In order to select a suitable treatment system, you first need to determine the parameters and characteristics of the raw water being pumped and know fluctuation margins for each parameter over time. In addition, you also need to define the types of treatment and the desired properties of the water once it has been treated.

Ion exchange systems

So-called ion exchange systems can be used to achieve the defined change in mineralisation. With these, certain ions can be exchanged selectively.
In the past decades, slightly acidic cation exchange methods have been used traditionally for water treatment in breweries. This method adjusts the hardness of water and its magnesium/calcium ratio.

One disadvantage of this process, though, is that the system needs to be regenerated regularly using chemicals. To regenerate an exchange system like this in a brewery, hydrochloric acid or sulphuric acid are usually used. This is an additional running cost that also needs to be considered from an ecological point of view.

Membrane processes

In recent years, so-called membrane processes have increasingly been established in the field of brewing water treatment. The physical basis for this is filtration. These processes function less selectively, as all substances are separated above the defined separation limit. The filtration process can be controlled by selecting the size of the membrane pores, the filter material and shape of the membrane.

Membrane processes can remove possible contaminants and generate the required water qualities in order to adapt water properties to brewing processes in an optimal way [8].

The application possibilities for membrane processes will probably gain in importance in the future, due to the increased relevance of groups of hazardous substances and the need to react to them.

Water treatment is one of the pivotal future topics for the industry. From 10–12 November 2020, you can find out more about this and other topics at BrauBeviale in Nuremberg, as well as at BrauBeviale@stage.

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