Reinventing the compact brewhouse

The banke two vessel system achieves six brews per day in the smallest possible footprint

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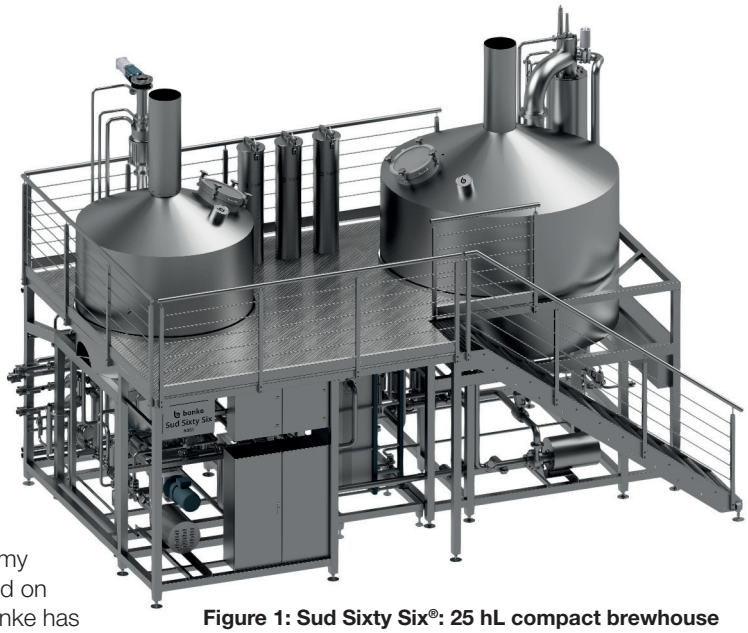

Figure 1: Sud Sixty Six®: 25 hL compact brewhouse for Engadiner brewery, mash-lauter tun (left), and whirlpool-kettle (right)

The novel compact brewhouse from banke GmbH combines many advantages in terms of technology, engineering and economy. With only two brew vessels and thus the smallest feasible footprint, a revolutionary six brews per day are achieved in 60 minutes of lautering time. Combined with a state of the art energy management system, the lowest possible energy consumption can be achieved.

A new type of mash-lauter tun and a whirlpool-kettle with energy-saving boiling system form the core of the two vessel system. Compact brewhouses with knock-out volumes from 5 to 100 hL with very high batch size flexibility are currently feasible. The plants are optionally combined with a new energy management system, thus achieving very low specific thermal energy consumption of less than 4 kWh/hL of cast-out wort.

Proven technology

The conical lauter and boiling systems are based on the brewhouse technology developed by Gilbert Moser as recently presented.[1,2] The concept has already been implemented in nine breweries with brew sizes of 2.5–40 hL. Reliable results on technology, wort quality, and economy are thus available. Based on an exclusive license, banke has further developed the concept with its own engineering and also optimized it in terms of energy (Fig. 1).

High flexibility in brewhouse work

The heart of the new concept is a combined mash and lauter tun in which the lautering surface is located in a cone (Fig. 2).

Mashing – infusion & decoction combined

Mashing-in is carried out by the banke pre-masher, which ensures ideal process conditions for high yields by homogeneous mashing right from the start.[3]

Mash heating is carried out by means of an external special heat exchanger and enables infusion and decoction mashing processes in only one brew vessel (Fig. 3).

In the case of decoction mashing, the partial mashes are overlaid on the residual mash at boiling temperature (95 - 99°C) and homogeneously mixed with the residual mash after starch disintegration. In this way, even problematic malts with high gelatinization temperatures, which are increasingly expected due to dry and hot summers, can be processed well. The decoction process is also used to produce lager beers full of character and to improve the haze stability of wheat beers. The single-vessel technology offers a high degree of flexibility in mash preparation and can be retrofitted to existing (conventional) plants without an additional mash vessel.

Figure 2: 40 hL mash-lauter tun with cone (left); Fürst Carl Castle Brewery, Ellingen Germany; view into the mash-lauter tun, special agitator with flow breakers and lauter sieve (right)

Lautering

The separation of husks and wort takes place according to a principle similar to that of a coffee filter. A hollow cone-shaped, loose and highly permeable filter cake is formed on the walls of the cone, which allows a very high permeability of wort with good retention of fine particles. The geometry makes use of the effect from cake filtration, a cake with equal resistance always builds up over a filter area. This behaviour enables the spent grains cake to be washed out evenly, which explains the good brewhouse yields. Unlike in classic lauter tuns, the spent grains cake remains largely in suspension throughout the process, so that the resistance that builds up is relatively small. In the lautering process, the first wort is displaced by sparging water and only at the end is the spent grains cake drawn dry for dehydration.

The high quality of the mashing and lautering work was confirmed in spent grain analyses (Table 1). The degradable and washable extract as well as the brewhouse yield were within the specifications of MEBAK (Central European Commission for Brewing Analysis) and the German brewhouse norm DIN 8777.

In addition to short lautering times, the patented mashing and lautering technology (EP 3 052 606) enables very high flexibility in lautering, as the conical lautering surface is already fully occupied with small mash volumes. Variations in wort OG from 6 to 24°P are feasible with different brew sizes of 40 - 100% of the maximum wort volume. These are ideal conditions for brewing marginal brands or experimental beers with smaller batch sizes, without having to compromise on wort quality. The mash and wort are heated via external heat exchangers, so that the vessels do not require heating surfaces and a defined and gentle heat transfer is ensured for highly variable brew volumes.

Spent grains removal takes place via a slide valve on the cone. The conical shape favours the draining (Fig. 2). In small plants, the spent grains can be collected in a mobile buffer tank. Alternatively, discharge is fully automatic via an eccentric screw pump. Low speeds and generous dimensioning of the pumps ensure a long service life and low maintenance costs.

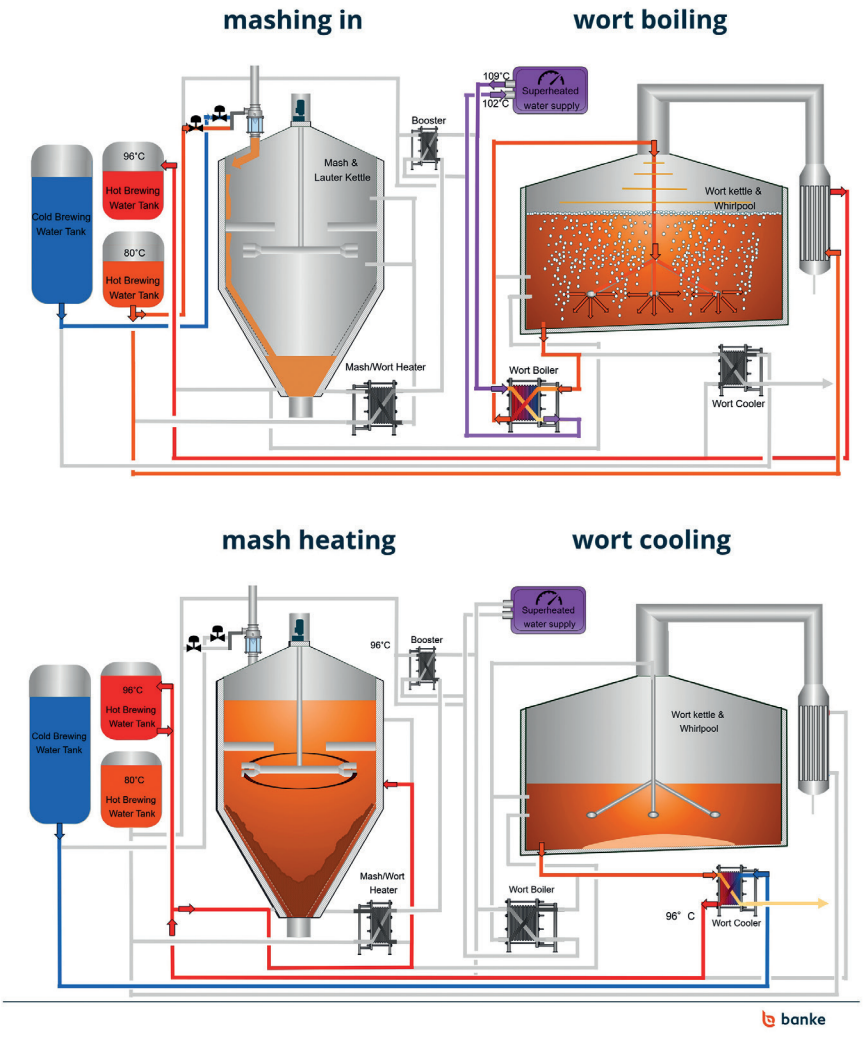

Figure 3: Flow diagram of selected production steps and thermal energy management

Wort boiling

The following goals were achieved in the development of the new boiling system:

- 2 % total evaporation for lowest possible energy consumption.
- 2 %/hr evaporation rate – very low heating power required for boiling.
- 109 °C heating temperature – the low heating medium temperatures allow cost-effective energy supply with wood pellet or wood chip heating systems frequently avoiding the need for costly and time-consuming certification processes.
- Best wort quality due to efficient evaporation and gentle heat transfer.

The wort boiling system operates according to the external boiler principle (Fig. 3). The heat transfer for heating and boiling the wort takes place via a special heat exchanger heated by heating water, which enables very low flow temperatures and also works very gently. The counter current flow of heating water and wort achieves a low thermal load and good heat transfer. The gentle heating with simultaneously high heating rates of 1 °C/min is reflected in the wort analysis data (Table 1). A low increase in the heat stress index (TBI) and stands for good flavour stability of the beers. The low decrease in coagulable nitrogen promises beer with very good foam stability.

Alternatively, heating can also be carried out with low-pressure steam.

The novel guidance of the heated wort below the wort surface in the kettle leads to an improved expulsion effect and thus achieves maximum evaporation efficiency with only 2 % total evaporation. The relaxation vaporization indicated by steam bubbles in Figure 3 ‘wort boiling’ leads to effective outgassing of undesirable flavours such as DMS. Excellent low values of this off-flavour were determined in worts at end of boil (11 µg/L, Table. 1).

Whirlpool

Hot trub separation is achieved by means of the classic whirlpool function. The vessel geometry is optimized for high hop loads to enable good trub separation with minimal wort losses.

High brew sequences

Due to the vessel combination of mash-lauter tun with a whirlpool-kettle, a very fast brewing rhythm is achieved. The total occupancy of the mash-lauter tun

is approximately four hours due to the extremely fast lautering time of only 60 minutes. The occupancy time of the whirlpool-kettle is well below four hours. Another advantage for the brewing rhythm is that the product is only ever transferred from the mash-lauter tun to the whirlpool-kettle, so that the two vessels do not block each other during loading, as is the case with the classic combination of mash and wort kettle with lauter tun. In contrast to a conventional two vessel brewhouse with a mash/wort kettle, the next brew can already be mashed in the new compact brewhouse during wort boiling.

For a beer with an OG of 12 °P, a brew rhythm of four hours can be assumed. For a comparable brew rhythm of a conventional brewhouse, two additional vessels, a separate mash kettle and a separate whirlpool are required. The total duration of a brew in the new concept is even shorter than in the classic three vessel brewhouse plus whirlpool, since heating is already started during lautering via the external boiler.

Highest energy efficiency in the brewhouse

In addition to the new external boiling system, the basis for the minimal energy consumption is the integrated energy management system.

The combination of a low evaporation rate ≤ 2 % and energy recovery allows the thermal energy requirement in the brewhouse to be reduced to below 4 kWh/hl.

The core of the energy management system is the recovery of wort cooling energy at the highest possible temperature using fresh brewing water. This energy is stored in a high-temperature stratified brewing water tank at two temperature levels. Likewise, the thermal energy from wort boiling is recovered. The higher temperature water of approx. 96 °C is available for direct infusion to the mash. The water stored at 80 °C is used for mashing in and sparging. As mentioned above in the text, the infusion process can be flexibly supplemented with decoction. In this process, the partial mash is heated by means of an external heat exchanger and largely with recovered energy.

With a heating water flow temperature of only 109 °C at the external boiler, renewable energies can be flexibly used for wort boiling, for example standardized and therefore cost-effective pellet or wood chip heating systems from regular building services and equipment suppliers. The use of solar thermal and power-to-heat is also possible.

Sud Sixty Six
Wort quality and brewhouse performance
60 minutes boiling period, 100% barley malt

Wort Quality Parameter	Unit	Start boiling	End of boiling
Extract, real	mas/vol.-%		11.98
pH-Level			5.58
Colour EBC	EBC	4.5	6
TBI		24.5	35.1 *MEBAK/DIN 8777: Δ <15*
Coag. Nitrogen	mg/100 ml	3.6	2.5 *>1.5 mg/100ml*
DMS free	µg/l	187	11 *<100 µg/l, off-flavour*
DMS-P	µg/l	159	52
Sum DMS	µg/l	346	63 *MEBAK: Sum DMS <100 µg/l*
Spent Grain Analysis	**Unit**		
Water content	%	76.4 *MEBAK/DIN 8777: < 82 %*	
Extract washable	%	3.9 *MEBAK/DIN 8777: < 4 %*	
Extract degradable	%	1.0 *MEBAK/DIN 8777: < 6,5 %*	
Brewhouse yield*	>76 % depending on malt quality and recipe *76 % = medium, >78 % very good* ** (0.96 (yield factor) x cast wort (hot) [hL]) / malt load [Kg]*		

Table 1 Wort analysis data of worts from 40 hL compact brewhouse

Summary

The new compact brewhouse achieves up to six brews per day with 60 minutes of lautering time by combining a novel mash-lauter tun with a whirlpool-kettle. The conical lautering surface not only allows very fast lautering with good yield, but also impressive flexibility in the grist load. Together with the small footprint, the brewhouse offers ideal conditions for micro and small breweries with an output of up to 150,000 hL per year.

The simple concept with only two vessels and the prefabricated frame units offers a clear advantage in investment costs compared to classic brewhouse systems, while at the same time requiring low maintenance. The low thermal power requirement and low energy consumption also make the system extremely attractive in terms of operation and investment in an energy supply system. Last but not least, the award-winning beers from the first plants show that first-class beers can be brewed with it.

The banke mash/lauter is working perfectly for distilleries too, as it functions as single vessel mash and lauter tun bringing the highest flexibility in mash thickness, grist load and mash volume as compared to conventional flat bottom lauter tuns. It achieves the perfect yield and wort qualities for fermentation and distillation, along with the lowest space requirements … which is something that distilleries maybe struggle with due to their old buildings.

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