A Novel Mash Filtration Process (Part 5)

BENEFITS OF OMNIUM | The Omnium by Ziemann® brewhouse concept that will be unveiled at drinktec 2017 is covered in the final part of a series of articles "A Novel Mash Filtration Process" published in BRAUWELT International and is the result of interdisciplinary research. Omnium is the integration of the novel Nessie by Ziemann® process for mash filtration, opening up new possibilities in brewhouse operation resulting from different approaches and wort composition.

COMBINED WITH advanced process engineering, current brewery technology makes it possible to design the brewing process in the best way possible. Every beer type desired can be produced with consistent product quality.

The question thus arising is why a functioning system should be fundamentally changed. The main reason is the fact that lautering takes a relatively long time, in particular evidenced by the cycle time of the lauter tun. Using current raw materials, especially homogeneous and high-enzyme brewing malts, mashing times of ≤ 75 min are possible. This leads to ambitious timing for subsequent process steps.

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The development of the new separation system Nessie by Ziemann® does not only lead to a shortening of the total process time in the brewhouse by approx. 30 per cent. It also results a decoupling from the mill type used – whether roller mill or hammer mill – and the characteristics of the raw material in terms of the parameters of malt dissolution degree and raw material portion in the grist load [1, 2].

Separation and Extraction

It is important to take advantage of savings potentials without having to accept any reduction in quality whatsoever. The new dynamic separation technology differs from conventional lautering procedures both in terms of extraction, separation (Table 1) and technology. The relevant process parameters are mentioned below, characteristic indicators are stated in parentheses:

- No O_2 uptake (wort colour);
- minor leaching (wort colour, concentration of tannins);
- low thermal stress (wort colour, thiobarbituric acid index, taste stability);
- higher yields (extract values of spent grains);
- higher zinc levels in pitching wort;
- higher turbidity in the kettle full wort (level of fatty acids);
- more solids in the kettle full wort (starch particles with photometric iodine reaction).

Trub and Solids

Trub and solids require an examination of technological issues. Other publications are in the pipeline to investigate them. The following findings can be summarised in advance:

An increased turbidity of the kettle full wort results in a high level of fatty acids in the wort. From the point of view of brewing knowledge, taste stability of beer, particularly due to long-chain unsaturated fatty acids as precursors of ageing carbonyls [3,4], as well as foam stability, mainly due to medium-chain fatty acids [5,6], may be negatively impacted. But it is also acknowledged that unsaturated long-chain fatty acids promote yeast metabolism and result in faster fermentation both during main and secondary fermentation [7], supported by higher zinc levels in the pitching wort. The resulting vital yeast eliminates the above-mentioned negative impacts on the finished beers.

The higher level of solids in the kettle full wort includes starch particles (grits) that lead to an iodine reaction during wort boil-

DIFFERENTIATION OF EXTRACTION AND SEPARATION OF DIFFERENT LAUTERING TECHNOLOGIES

	Separation/Filtration	Extraction/Leaching
Lauter tun	static	static
Mash filter	static	static
Nessie	dynamic	dynamic

Table 1

ing. This is countered by adding a malt extract after boiling, evidenced by guaranteed low iodine values (Fig. 1).

The novel separation technology opens up new technological possibilities that are reflected in the Omnium brewhouse concept. The conventional brewhouse is modified and, in addition to integration of Nessie, extended by the modules described below (Fig. 2):

I. Addition of a malt extract after boiling for guaranteed low iodine values in pitching wort

The malt extract is predominantly taken from wort running off wheel 1 of the new system at a temperature of 72 °C, stored temporarily in a buffer vessel and added after wort boiling at a temperature of approx. 80 to 85 °C. This results in complete saccharification of dextrins formed by digestion of starch particles during boiling. As a result, risks associated with a high iodine value such as filtration problems, haze in the finished beer, microbiological instability and off-tastes can be avoided [8]. The prevailing temperature of 80 to 85 °C causes inactivation of amylases in the malt extract for the rest of the time.

II. Separate, external hop isomerisation and addition after trub removal for increasing hop yield

External hop isomerisation creates optimum conditions for any particular hop product. In the Nessie system, the isomerisation liquid is equivalent to the standard last runnings. In view of a higher pH range of 5.7-6.1, depending on the quality of the sparging liquid, and a lower original gravity of about 1.0 °P, it has a positive effect on isomerisation and associated yield. On account of separation, temperature and time can be adjusted to hop isomerisation and prevention of degradation reactions of iso-α acids [9]. The isomerised hop liquid can then be used both in the hot and cold section without any microbiological risk.

III. Controlled trub removal in the sedimentation tank to retain physiologically important components

Conventional hot break and, possibly, cold trub removal adsorbs a major amount of fatty acids still present after boiling. These are thus no longer available for an optimal fermentation process [10]. The same can be said for the zinc trace element. This gave rise to the idea to leave a certain amount of trub that accumulated in the sedimentation tank in the wort.

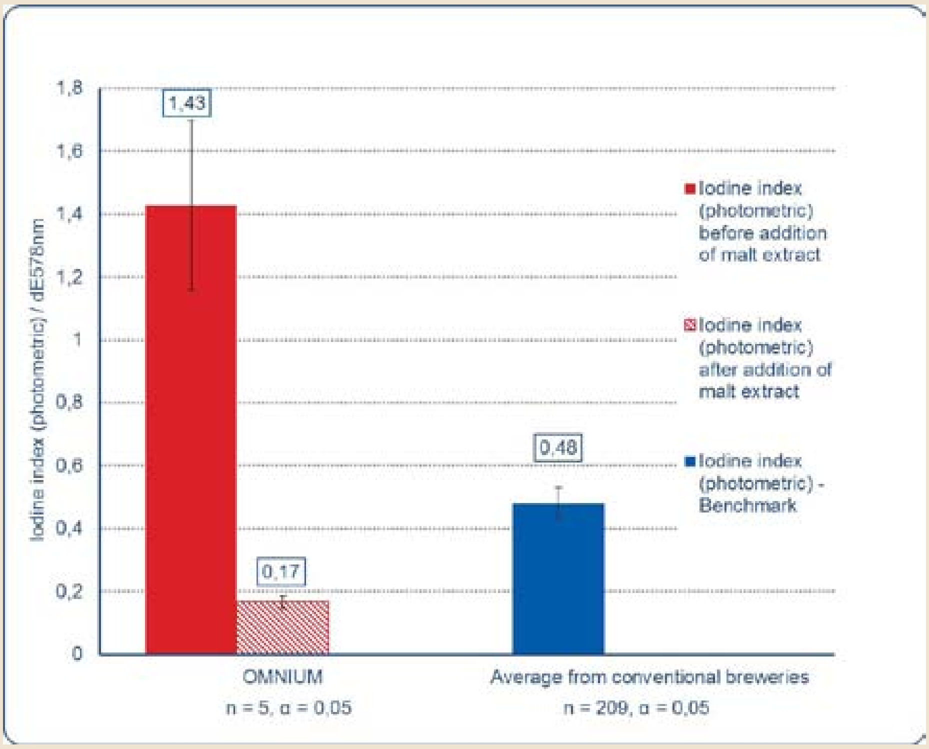

Fig. 1 Photometric measurement of the iodine values before and after dosing the malt extract, benchmarking current industry figures for cold wort according to Research Center Weihenstephan for Brewing and Food Quality, (Analysis with buffered method, standard value < 0,45; MEBAK – Wort, Beer, Beer-based Beverages, Edition 2013, p. 53)

PRACTICAL VALUES OF THE WORT QUALITY (HALF-TIME WORT COOLING) USING DIFFERENT LAUTERING TECHNOLOGIES

Parameter	Nessie	Lauter tun
Colour [EBC]	5.5	7.3
TBI [-]	38	50
TBI increase [-]	18	30
Furfural [µg/l]	212	431
Viscosity [mPas]	1.80	2.10
Polyphenols [mg/l]	142	240
Anthocyanogens [mg/l]	58	92
Tannoids [mg/l]	22	85
Silicon ions [mg/l]	9	14
Iodine index [dE 578 nm]	0.18	0.70
Zinc ions [mg/l]	0.63	0.01
C 18_1/2/3 [mg/100ml]	2.00	0.12

Table 2

Wort Quality

A total of more than 100 test brews with batch sizes of 10, 50 and 140 hl of cast wort have meantime been carried out and analysed on a commercial scale. The process described, using the Omnium system, is reflected in an improvement of the wort parameters described below (Table 2):

Compared to lauter tun worts, wort colours at half-time of cooling of Nessie brews are about 2 EBC lighter. Thermal stress in Nessie brews, expressed by the thiobarbi-

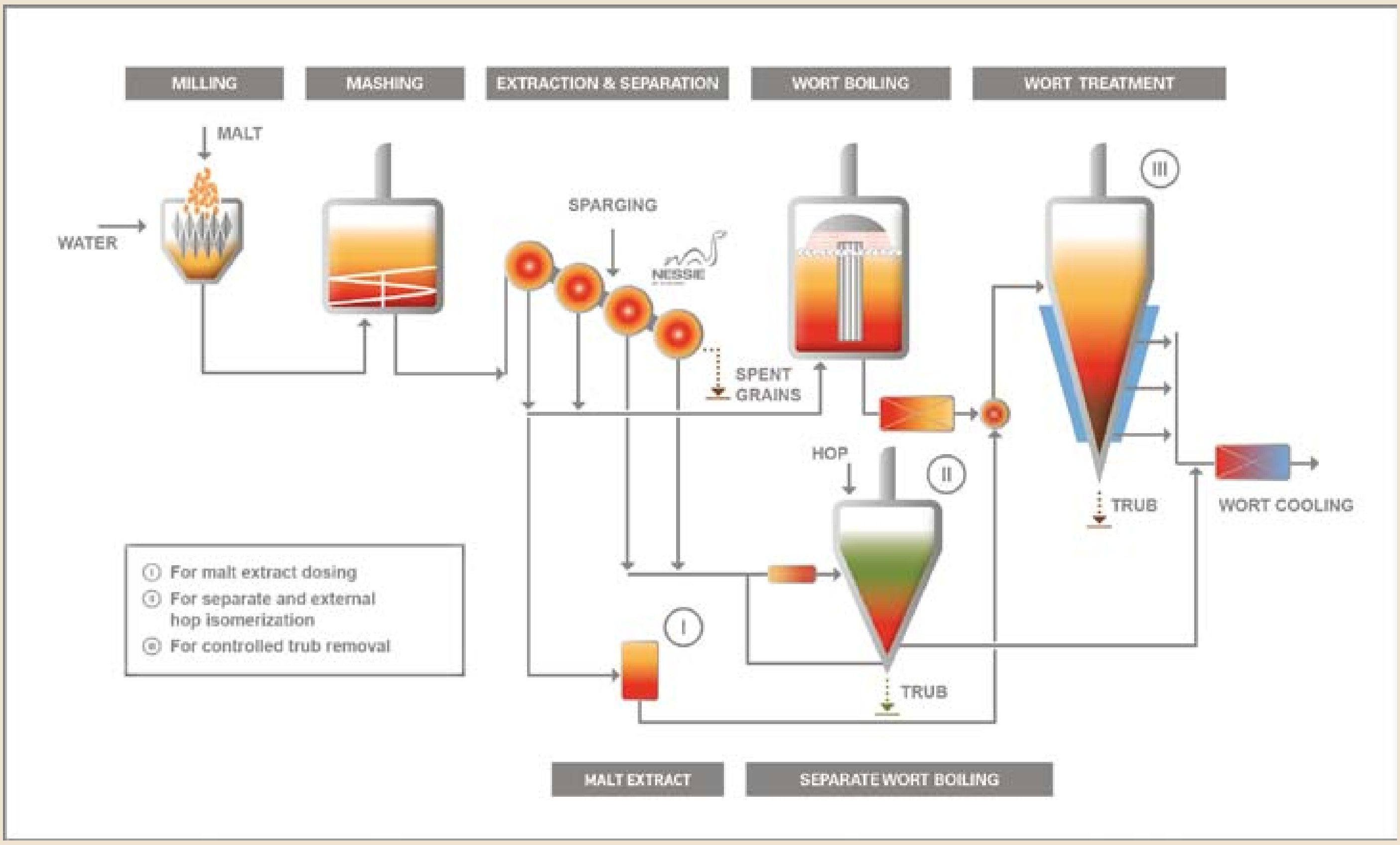

Fig. 2 Schematic illustration of the novel brewhouse concept

turic acid index (TBI), is significantly lower. The TBI is 10-15 points lower in terms of an increase from kettle full wort to half-time of cooling and of absolute values at half-time of cooling than in comparable lauter tun brews. Thermal stress could thus be reduced further during trub removal from the sedimentation tank, induced by the short separation time and the low temperature of 80-85 °C. This is also confirmed by a low furfural level in the worts and suggests a positive effect on flavour stability.

A favourable viscosity of 1.80 mPas, compared to lauter tun values of 2.10 mPas, is probably attributable to breakdown of α-glucans still present achieved by dosing the malt extract after boiling. Beer filterability might thus be improved further.

Tannin levels are down by about 40 per cent. Silicon levels in Nessie worts are also lower. This can be attributed to a shorter contact time during mash separation and an associated lower degree of leaching from the husks. Mash particles remain in the separation system for three to five minutes, having a positive effect on colour. As a result of addition of the malt extract after boiling, the iodine value remain low. The trace element zinc is higher by some orders of magnitude at 0.63 mg/l. Given the German Purity Law, this cannot be achieved otherwise in the brewhouse.

Fermentation and Maturation

A minimum level of zinc of 0.15 mg/l in the cast-out wort is another goal for rapid main fermentation, good yeast propagation and complete diacetyl breakdown. Using the novel separation technology, zinc dissolved out during mashing is largely maintained as it is not retained in the spent grains layers. The same can be said for long-chain unsaturated fatty acids. Purposeful adjustment of trub after the sedimentation tank also maintains zinc and fatty acids for yeast metabolism. Such optimised supply of nutrients is reflected in stronger yeast propagation. The population is very vital, with few dead yeast cells. Extract breakdown proceeds more rapidly. Though the strong fermentation leads to a higher maximum diacetyl value, this drops faster during secondary fermentation [11].

Beer Quality

The objective of the test series was to produce the character of a bright full beer. Extract, alcohol and bitter substances show that this beer type was achieved. The bright colours, lower by approx. 1.5 EBC than those in comparable beers from a conventional brewhouse, are noteworthy. The process also achieves very high degrees of fermentation. In view of low tannin levels, the high chemical-physical stability of the beers is not surprising. For the particular beer type, fermentation by-products are in the standard range and confirm the optimised fermentation procedure. As mentioned above, the good taste stability of the beers can be attributed to stimulated yeast metabolism. Even medium-chain fatty acids are completely metabolised by the yeast and do not impair foam, reflected by excellent foam values (Fig. 3).

In general, the beers were convincing in taste. Tasting according to DLG criteria (smell, taste, body, carbonation and bitterness) yielded superior scores.

Further Savings Potentials

Using the process described, significant time savings are possible which, in turn, raise productivity. Moreover, specific production costs go down, resulting from optimised raw material yields and supplemented by synergies achievable in fractionation and combining wort streams. These effects are an advantage, in particular when using thermal energy.

Conclusion

The novel brewhouse concept offers numerous benefits for the whole brewing industry: as complete saccharification during the last process step in the brewhouse is assured and hop isomerisation is a separate step, process times go down during mashing and wort boiling. Conventional wort lautering has become a transfer step. Thanks to Nessie, real brewing times go down by anything up to 30 per cent. As valuable components are largely maintained, yeast has a better supply of vital nutrients available in the Omnium wort, main and secondary fermentations are accelerated which is equivalent to higher cellar capacity.

Yield of raw materials is also improved as all extraction processes proceed dynamically when the right time has come. Fluctuating malt qualities can be offset by saccharification after boiling when malt extract is added. Omnium is also in a position to optimise quality of beers brewed. Thanks to the gentle brewhouse process and rapid fermentation, haze stability of the finished beer goes up considerably, beers have excellent foam properties and outstanding taste stability. An increased wort and beer variety is another benefit while complying with the Purity Law. ■

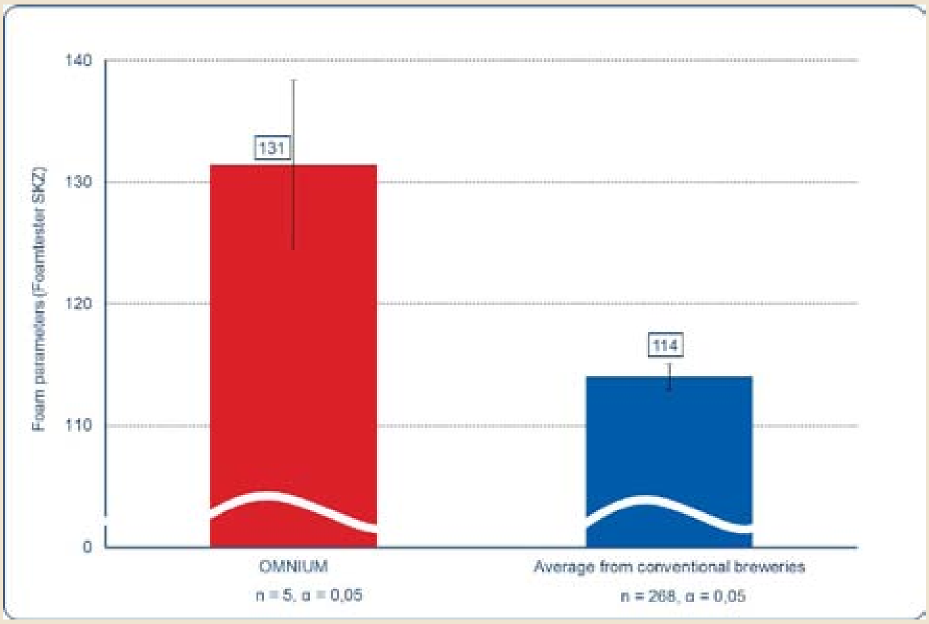

Fig. 3 Analysis of the foam parameter in the finished beers, produced with the novel brewing process, by means of a foam tester, benchmarking current industry figures according to Research Center Weihenstephan for Brewing and Food Quality

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