NEW SCANDINAVIAN SCHOOL OF BREWING CONCEPT: 'FUTURE BREWERY – 2020'

PART TWO

AXEL G. KRISTIANSEN, SSB DIRECTOR, E-MAIL: AGK@BREWINGSCHOOL.DK

In two articles in the SBR, Axel G. Kristiansen describes the recent SSB concept of outlining the state of the art of a large sized brewery anno 2020 and the most important technological achievements resulting in this state of the art. This is the second article covering the process from beer stabilisation and onward. The first part of this paper was published in the October (5/2011) issue of the SBR.

The scope for the present paper is breweries producing international lagers of 200,000-500,000 hl/month, few SKUs, i.e. less than five worts in the brewhouse and one or two yeast strains only. These breweries will be equipped with beer- and yeast recovery systems, have a complete range of small pack packaging lines and all utilities supplies including a waste water treatment plant.

STABILISATION

Breweries largely now rely on PVPP, Silicagel or a combination of these two chemical stabilizers, both working well to prevent formation of permanent hazes. However, both stabilizers are costly and require the beer chilled to temperatures below 0 °C to become effective.

The development of a proline-specific endo-protease type 'Brewers' Clarex' from DSM that hydrolyzes the haze-active proteins is therefore likely to replace PVPP and Silicagels, partly for cost of stabilizers, but definitely to save cooling energy, as the beer with this treatment can be sent to the beer filter at 4-7 °C. Beer at 4-7 °C is even an advantage in the later beer bottling operation, as classic problems with condensation of water on bottle labels can be avoided.

For cheaper beers, and for beers with short shelf life, i.e. three months, some breweries may consider not to chemically stabilize their beers at all. They may save chemicals and a process step, but will need at least to chill their beers before filtration.

FILTRATION

Kiselguhr filters (KGFs) will be around also in year 2020, as this technology is still installed in most breweries, and some breweries still prefer a technology well understood. But large, new breweries will increasingly prefer cross-flow filtration (CFF) technology, because the initial development challenges have been overcome, and there are advantages with power and water consumption using CFF*. Several CCF solutions are now commercially available.
In addition, a CFF plant can be put right in the packaging hall, supervised by the filler operator, as CFFs are not as labour demanding as are KGFs. Quality-wise there seems to be little difference between CFFs and KGFs, so – again – the driver becomes economy.

Both KGFs and CFFs rely on an efficient tank bottom removal by a high speed centrifuge just prior to the beer filter. Recent improvements in centrifuge technology suggest that we may approach a time where some beers will be sufficiently bright after just passing the centrifuge, not demanding a filtration. As there will be traces of microorganisms, a pasteurisation of the centrifuged beer will no doubt be useful.

Whether the brewery uses KGF or CFF, by year 2020 many breweries will finish their beers during filtration: Add spices, hops, syrups, flavours, other beers or just de-brewing liquor. As mentioned during the brewhouse discussion, breweries will by 2020 create much more final beers during filtration than they do genuine brewing. Company Symrise suggests 'One single wort type for a variety of brands: pilsner, stout, wheat beer, non-alcoholic beer' by addition of flavourings (www.symrise.com).

The 2020 brewery will therefore need comprehensive blending facilities in the filtration department.

BRIGHT BEER

The Bright Beer Tank (BBT) may not forever remain as such, offering min. one BBT per filter line plus one more BBT per filler line, plus one stand by BBT, as in-line carbonisation, blending and gravity- and colour adjustment is now possible en route to the filler.

BEER PACKAGING

In most of the world, the returnable glass bottle is retiring, and this trend is not likely to stop except for countries, where legislation favours returnable glass bottles.
PET bottles have recently improved their barrier characteristics to such quality that bottling premium beers in PET is possible, as we already see in Eastern Europe and the Baltics. More PET filling lines operating with pre-forms and a blow moulder prior to the filler will be installed, as they may serve also for packaging soft drinks and waters.

As for the packaging lines, the drive to increase speed at lines will not continue: Most breweries do not prefer glass lines faster than 60,000 bottles per hour and can lines faster than 100,000 cans per hour. Lines already in operation with higher output are anyway equipped with duplicate machines for EBIs, fillers and labellers.

Packaging machines are huge investments, and the practice that the so-called 'packaging-V' demands palletiser and depalletiser to have 40-50 per cent higher capacity than the filler may well be challenged. It is expected, that the palletiser/depalletiser overcapacity will be reduced to 15-20 per cent to save machine costs, space and buffers. Consequently, this will give rise to increased demand at the packaging lines to avoid short stops, nowadays costing either lost efficiency or huge buffers and machine overcapacities.

→

Students at SSB examining a hollow Cross Flow Filter module.

SSB Students examining a label magazine.

SSB students monitoring CO_2 flow

Volumetric fillers will come further down in price, gradually replacing classic level fillers.

Self-adhesive labels and no-label-look labels will further increase in popularity– adding to packaging material costs.

To compensate the increased packaging material costs, brewers will further standardize their container sizes. This way they achieve longer filling runs and avoid costly change-overs.

PASTEURISATION – OR NOT?

The brewing world is not quite united in determining method of pasteurisation – or even whether to pasteurise or not. Several studies, also one by SSB students in 2008*, compare microbiological safety, investments and space costs, manning demands and operational costs between flash pasteurisation and tunnel pasteurisation, and the outcome remains unclear.

Some breweries have introduced sterile filtration instead of pasteurisation, a technology first tested in the 1980s, but since then not gaining much popularity because of strict hygiene requirements demanding time for additional cleaning.

The global divided approach to pasteurisation, sterile filtration or aseptic filling generally speaking is a slow move from tunnel to flash pasteurisation and some countries (e.g. Germany) filling beer aseptically, i.e. without pasteurisation.

BREWERY UTILITIES

The utilities managers in the brewery are coming out of their shadow as the stepchild of the brewers, because a) cost of utilities is rising faster than inflation, b) environmental demands increase and c) the utilities are becoming the newer target for cost reductions, as the brewing and beer processing have long been. Increasingly, 'Sustainability' is becoming a critical headline before major investments and decisions are taken.

Heat supply:	Gas boilers not delivering 96 per cent efficiency will be improved or replaced. Newer type boiler economizers will allow smoke temperature < 50 °C. Condensate return systems for steam boilers will become more efficient, and volume targets for returned condensate increased.
Power:	Supply of electricity remains most often from the national grid, but some breweries will find it economically attractive to install a Combined Heat and Power (CHP) plant. A CHP plant designed to supply the needed heat will normally deliver more than the needed electricity, so the brewery will need to sell electricity, if it runs a CHP plant.
Cooling:	Use of brewery plant underground to chill the cooling circuit will become attractive, except for tropical areas. To a greater extent a move from two-stage cooling circuit to one-stage cooling circuit only by direct expanding NH_3.
CO_2	CO_2 recovery will still only be installed if economically attractive. The brewery CO_2 supply plant will be of the 'Liquivap' type to re-use the cooling energy from the evaporating CO_2 .
Water:	Efforts already spent to reduce the water: beer factor from nowadays approximately 4:1 will continue, and a target of 3:1 will become achievable for many breweries by year 2020.
Material:	Stainless steel will lose its monopoly as the preferred and only material for hygienic tank and pipe construction for beverages, water and even steam supply, as new food grade Poly Ethylen (PE) materials are available and able to withstand high and low temperatures, chemicals and offer longer life than stainless steel.

WASTE WATER TREATMENT PLANT (WWTP)

The technology for anaerobic WWTP producing biogas, supplying 15 per cent of the brewery needs for boiler gas is in place – we expect many implementations of this concept, as it serves both energy conservation (environment) and cost savings. Brewery production waste will become increasingly valuable, as it becomes possible to generate biogas from more waste sources like spent grains and surplus yeast.

WAREHOUSE

Just in Time (JIT) is nothing new, but still some breweries may benefit from shorter stock time for all material supplies and for finished products. To achieve a good JIT, fast raw material and packaging material rotation is required, but the benefits are clear: Reduced work-in-progress = reduced cash demand.

Malt storage for only 24 hours is manageable, and empty cans and one way bottles may arrive continuously as needed leaving no stock, as long as the suppliers carry a preferred supplier status and guarantee the quality for each batch.

Hi-bay warehouses will prevail in some breweries, where price of land or internal plant transport costs get high. In other breweries, the concept of no warehouse may become attractive, demanding trucks/trains ready to be filled directly from packaging lines.

SUPPLY CHAIN MANAGEEMENT (SCM)

Large breweries increasingly seek to avoid depots and opt for Direct Store Distribution (DSD) from packaging lines to large supermarkets. When possible, much time and value of stock is to be saved. In practice, a brewery may operate direct supply delivery to large supermarkets and at the same time continue to distribute from a picking area for smaller customers.

CONSUMPTION DATA

Going through the entire brewery in the flow of the manufacturing process as here documented, substantial improvements in consumption data are still achievable. The table below is our proposal for the past, the present and the future brewery by year 2020.

STAFF AND TRAINING

Operators will increasingly also do maintenance jobs, weekly planning of production, weekly call-off of supplies of raw- and packaging materials and QA jobs. Only few unskilled operators will remain in the brewery as the breweries drive automation further.

Parameter	Data year 1980	Data year 2011	Data year 2020
Farmers malt barley yield	4 t/ha	7 t/ha	8.5 t/ha
Malt consumption for 1m hl lager beer	16,000 t	16,000 t	0? (if replaced by barley)
Alfa acid content in raw hops	10%	15%	18%
Bitterness in lager beer	25 BU	20 BU	16 BU
Heat consumption	40 kWh/hl	18 kWh/hl	12 kWh/hl
Electricity consumption	13 kWh/hl	8 kWh/hl	6 kWh/hl
Factor water/beer	9 hl/hl	3.5 hl/hl	< 3 hl/hl
Consumption of yeast	1 kg/hl wort	1 kg/hl wort	1 kg/hl wort
Yeast re-production	2.7	2.0	1.7
Extract loss in entire brewery	15%	7%	4%
Productivity	2,000 hl/FTE	20,000 hl/FTE	40,000 hl/FTE
Packaging line utilisation	70%	70%	80%
Biogas amount of all heat supply	0%	12%	18%

Proposal for the past, the present and the future brewery by year 2020

➜

QUICK WINS

Large breweries face many challenges: Many have in the past been sought overcome by capital investment projects driven by brewers' wish for trying out new technology, often offering less manual work and in this way contributing to the payment by staff reductions.
As seen from above, still much improvement work is possible at no or little capital investment costs, for example higher HGB-degrees, thicker mashes, reduced yeast reproduction and more blending of final beer at filtration just to mention four.

Perhaps this type of work needs more attention, and perhaps more brewery staff needs the education and experience to manage these process tunings?

SSB

As from 2010, SSB has made 'Future Brewery 2020' part of the syllabus for the Diploma Master Brewer study, now jointly run with KU LIFE, University of Copenhagen.

SSB has also conducted a special course 'Future Brewery 2020' SEP 2011 at SSB for brewers wanting to hear about this concept in more detail. This course will run again in September 2012.

ACKNOWLEDGEMENTS

Thanks to Kim L. Johansen (training manager, SSB) and the Diploma Master Brewer Class at SSB 2010/2011.

REFERENCES

The author of this article has a complete list of references for the background statements and results referred to in the article (generally indicated by an asterisk(*) in the text). The list of references can be obtained by contacting agk@brewingschool.dk.

ABOUT THE AUTHOR

Axel G. Kristiansen, MSc. in Food Science & Technology and Diploma Master Brewer (SSB), Director of The Scandinavian School of Brewing (SSB) in Copenhagen since 2004 and since 2011 also external Associate Professor at University of Copenhagen. From 1984 to 2004, master brewer in various technical management positions with Carlsberg Breweries A/S in Denmark, in the UK and in Italy. In his spare time, Lieutenant Colonel in the Royal Danish Air Force Reserve.