FOOD & BEVERAGE

Technical Article

Improving Sustainability of Brewing with Pall Beer Systems

Introduction

The brewing industry has the reputation of being conservative. Brewers today are often using technology developed decades ago which has been optimized over time to improve operational processes and efficiency. As a result, this machinery is typically very well fit for purpose.

Simultaneously, there has been ongoing innovation to create new production equipment, but research and development in brewing has often followed the goal to improve product quality and minimize operational costs of production. In today's environment however, there is increasing consumer and regulatory pressure driving brewers to also prioritize sustainability. Accordingly, research indicates that 85 % of people worldwide have shifted their purchase behavior towards being more sustainable in the past five years[1] and as MEP National Network states: "The food industry is likely to face increases in regulations pertaining to emissions, resource use and waste."[2]

Improving Sustainability in Brewing

There are three aspects of sustainability:

- Environmental sustainability
- Social sustainability
- Economic sustainability

All can be addressed in brewing with selection of the appropriate technology and running the processes intelligently. Additional leveraging of digitalization and internet of things (IoT) can also help to improve performance.

To address environmental sustainability, obvious examples would be reducing water and energy consumption and minimizing accumulation of waste. Less obvious but also of great importance in a world with an ever-growing population, is efficient use of all raw materials, not only looking at water.

Social sustainability is about identifying and managing impacts on people. As an example, breweries can impact this by making sure that they implement food safety programs to ensure that critical ingredients such as heavy metals stay below the legal limits (*e.g.,* arsenic). Additionally, it is important to ensure that hazardous substances are handled correctly so they do not negatively impact operator safety or the local community, which could be affected longer term through waste streams leaching into the ground or waterways.

Economic sustainability is aimed at achieving economic growth without negatively impacting environmental trade-offs, for example economic gains as a result of decreasing consumption of raw materials, waste or utilities.

Contribution of Pall Beer Systems

As a forward-thinking company, Pall has been a technology leader with the courage and foresight to be pro-active in setting up products to be more sustainable. Pall's portfolio of beer systems has been designed to ensure consistent, high-quality product but also consider the key environmental, social and economic factors.

DE Replacement

In the early 2000's, Pall decided to stop producing DE (diatomaceous earth) or Kieselgur filters. In a time where DE usage was the dominating technology to filter beer, Pall focused its innovation efforts on crossflow membrane filtration for beer clarification, predicting the necessity to eliminate DE in beer production.

While it is becoming a challenge to even get the desired quality of DE into breweries, there are numerous other factors where replacement of DE has a positive impact on sustainability:

- CO_2 footprint
  - Manufacturing membranes for beer filtration shows only a fraction of the greenhouse gas emissions compared to mining, milling and heat treatment to produce DE powder of the needed quality for brewing (relative to the same amount of produced beer).
  - The overall CO_2 footprint of beer filtration can thus be reduced significantly.
- Water consumption
  - In membrane filtration, there is no need for pre- and post runs and together with smaller vessel volumes (as compared to DE filters for the same level of beer throughput), the water consumption can be lowered significantly.
- Energy consumption
  - Pall has done many projects in the past, replacing DE filters with the PROFi membrane filter system with results indicating that both the consumption of electrical and thermal energy could be significantly lowered.
- Reduced beer loss
  - For the same reasons that enable significant water savings when comparing crossflow membrane filtration with DE filtration, a significant reduction of beer loss is also possible (no pre and post runs, emptying with CO_2, small vessel volumes).
- Eliminating DE powder
  - By eliminating DE from the beer process, brewers can also eliminate:
    - Exposure to DE powder, which poses a cancerogenic risk[3] if inhaled
    - Additional equipment necessary to transport, store and handle dry DE and DE waste becomes obsolete
    - The accumulation of solid waste. In breweries of industrial scale, the mass of DE waste amounts to hundreds of tons per year which in many countries/states[4] requires treatment as hazardous waste.
    - The possibility of metal ions from the DE leaching into the beer with possible consequences for product quality and food safety[5].
    - The necessity to run in batch operation. Membranes offer the option to move to continuous operation which results in a more efficient system utilization combined with minimized resource consumption.

PROFi membrane system for DE-free clarification of beer

CBS – Beer Stabilization

Many brewers look to increase the colloidal stability of their filtered beers by utilizing one of the various stabilization technologies.

By installing Pall's CBS beer stabilization system with regenerable PVPP in a fixed bed technology, the following sustainability advantages can be achieved:

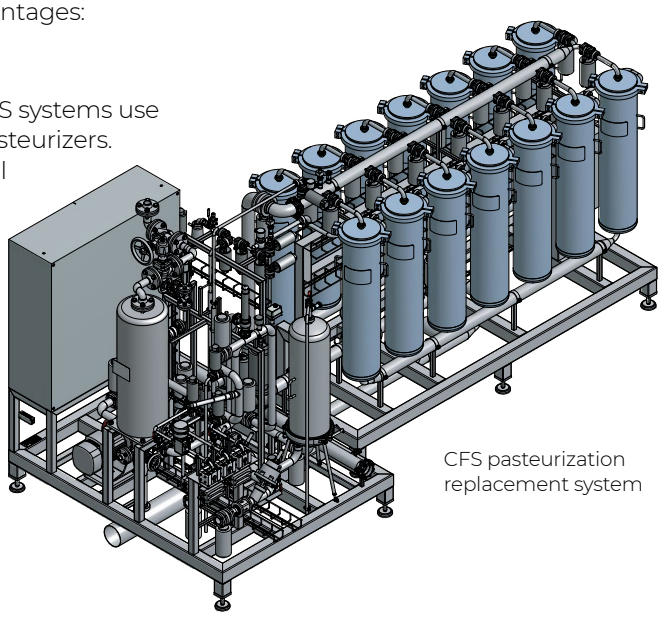
- Water and cleaner consumption
- With a very low hold-up volume of the PVPP-filled columns, the consumption of cleaning chemicals, water and energy are significantly reduced when compared to other PVPP regenerating technologies. The volumes are so low that there is no need for a dedicated CIP unit.
- The loss rate of PVPP is negligible, typically at < 0.3% over a total of 1000 regeneration cycles. This corresponds to a run time of 2 to 3 years before the PVPP in the cassettes require a change-out (due to exhaustion of the PVPP surfaces). With lowest in class PVPP loss rates, this also results in the lowest in class waste accumulation of spent PVPP.

CBS beer stabilization system

CFS – Pasteurization Replacement

Deciding not to remove microorganisms by inactivating them with heat, but to remove them via filtration at cold temperature is as simple as it is efficient. Membrane filter cartridges can be checked using *in-situ* integrity tests before each run to ensure highest microbiological safety. Furthermore, the design of Pall CFS systems has been optimized for this cartridge filtration to realize the following sustainability advantages:

- Reduction of energy use
- In addition to the obvious reduction of thermal energy, Pall CFS systems use significantly less electrical energy than the majority of flash pasteurizers. This benefit is only heightened when comparing CFS to tunnel pasteurizers.
- Water use and beer loss
- A CFS system basically works "as a piece of pipeline." The product is simply pumped through cartridges that hold the filter membranes; a buffer tank is not required under standard installation conditions. For this reason, the hold-up volume of the system is minimized and in case of production stand-still, the product in the system does not suffer over-pasteurization; neither recirculation nor push out is necessary.



CFS pasteurization replacement system

Keraflux™ Beer Recovery System – Improving Raw Materials Efficiency

A typical industrial scale brewery usually has around 2 – 3 % of its annual output as recoverable beer in the sedimented yeast post fermentation. For breweries with a variety of brands and small batches, these numbers can increase to greater than 15% — which poses significant losses and poor efficiency of raw material use.

The Keraflux system, utilizing ceramic membranes in crossflow operation reaches beer recovery rates in the range of 80 – 90%. The recovered beer has the same quality as the intended brewed beer and is typically blended back to the original batch, thus increasing production yield and the overall output of the brewery.

The Keraflux system has a short brewery return on investment (ROI) and is sometimes described as a “money-printing machine” — next to it being able to improve sustainability of beer production.

Keraflux beer recovery system

Continuous Production – Optimizing Plants and Workflows

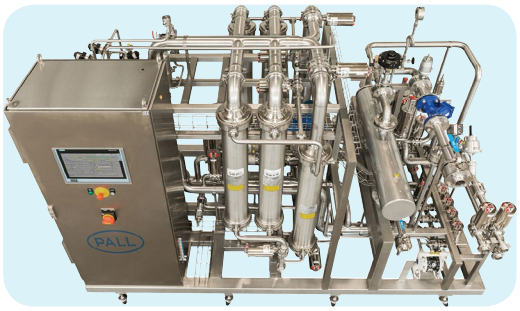
Implementing continuous production into brewing has often been investigated throughout the history of brewing research and development. Continuous processing has been tried for good reasons as described below.

A transition from a classical batch production to a continuous production process offers significant potential savings at different stages:

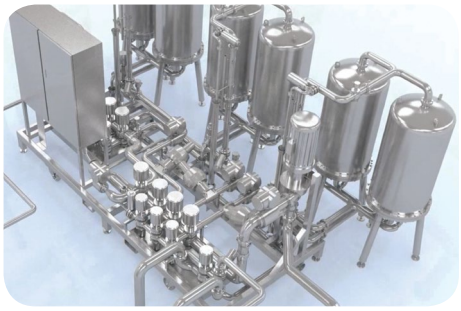
- Lower facility costs would result based on the capability to design smaller production facilities, thus contributing to economical sustainability.
- Reduced labor costs could be realized due to automation and continuous production (again economic sustainability).
- Potential improvements in raw material and consumable efficiency, therefore improving environmental sustainability
- Lower system hold-up volumes that consume less energy and media could have a positive impact on the environmental sustainability KPI’s.

Pall's forward-thinking engineers designed their single systems such that they can work together in a continuous way. The unique workflow makes Pall one of the very few suppliers in the brewing equipment world that has true credibility in continuous production:

- PROFi beer clarification lines consist of separate membrane blocks (MBLs) that can alternate between production and regeneration so that the flow of product is kept constant, independent from the filterability of beer. The run length of the single blocks may vary, but the general set-up will produce continuously, independent from the beer characteristics.
- CBS beer stabilization systems consist of at least three columns that hold the fixed-bed PVPP so that the system can maintain up-time by switching the single columns between production and regeneration. Ideally, it can be coupled downstream of a PROFi system as part of a modern brewery continuous filtration and stabilization line. With the CBS system, the stabilization intensity can be adjusted at a switch of a button with different "recipes" in the control parameters so that even changing requirements for stabilization can be obeyed while the system produces.
- With the CFS final filtration (pasteurization replacement) system, beer is pumped through the membranes between the bright beer tank (BBT) and filler. If very long runs at the fillers are needed, Pall is able to set up the line with "twin blocks" so that operation can be switched between production and regeneration. After every regeneration, an automated integrity test of the membranes is implemented. In case a membrane integrity failure is detected, a small cluster of the membranes can be shut off so that the rest of the unit continues producing, allowing for replacement of the damaged membranes while production is ongoing.



PROFi beer clarification


CBS beer stabilization


CFS final filtration (pasteurization replacement)

IoT Application – Using the Power of Data to Optimize

A modern and automated brewery processes a large amount of data during operation, which often far exceeds our imagination and thus the possibility of data evaluation, use and optimization. Pall offers cloud-based technology at the highest possible security standard to realize optimization potential through evaluating data from automated processes.

In real life, breweries are using the data seldomly. In most cases, effort and manpower is necessary to generate meaningful analysis combined with process improvements. Without leveraging IoT, analysis and process improvements are typically not realized as additional value for the brewery. Thus, the system operates on settings established at commissioning, and the process is never optimized further based on data collected.

Utilizing IoT, an optimization of the process based on a data analysis can save running costs between 10-30%. These values can be further improved if the data is used in a second step for self-optimization of the system. The production system can be operated at the optimal process status through continuous data analysis and the associated constant process adjustment. By using algorithms for process control, the production system learns, independently of the operator, under which conditions the longest service life, the lowest water and energy consumption so the maximum utilization are achieved.

Conclusion

In today's brewing industry there are opportunities to achieve significant savings, resulting in lower emissions, higher raw material (including water) efficiency with positive impact on product quality and environment. Years ago, Pall stepped out of the production of traditional filter-aid based technologies and developed systems for breweries that are a perfect fit to meet today's sustainability requirements. Pall continues to innovate and further develop its systems, as is apparent with the example of implementing IoT for continuous improvement.

Footnotes

[1] www.businesswire.com/news/home/20211014005090/en/Recent-Study-Reveals-More-Than-a-Third-of-Global-Consumers-Are-Willing-to-Pay-More-for-Sustainability-as-Demand-Grows-for-Environmentally-Friendly-Alternatives

[2] Five Trends That Will Impact the Food Industry For Many Years, MEP National Network

[3] www.bgn-branchenwissen.de/daten/asi/a8_02/2.htm

[4] nj.gov/health/eoh/rtkweb/documents/fs/0616.pdf

[5] www.yumda.com/en/news/1159724/keeping-heavy-metals-out-of-beer-and-wine.html

PALL CORPORATION

+1-866-905-7255 **Food and Beverage toll free**
foodandbeverage@pall.com

Corporate Headquarters
Port Washington, NY, USA
+1-800-717-7255 toll free (USA)
+1-516-484-5400 phone

European Headquarters
Fribourg, Switzerland
+41 (0)26 350 53 00 phone

Asia-Pacific Headquarters
Singapore
+65 6389 6500 phone

Visit us on the Web at www.pall.com/foodandbev

Pall Corporation has offices and plants throughout the world. To locate the Pall office or distributor nearest you, visit www.pall.com/contact.

The information provided in this literature was reviewed for accuracy at the time of publication. Product data may be subject to change without notice. For current information consult your local Pall distributor or contact Pall directly.

IF APPLICABLE Please contact Pall Corporation to verify that the product conforms to your national legislation and/or regional regulatory requirements for water and food contact use.

FBTABEERSUSTEN
FEBRUARY 2023