

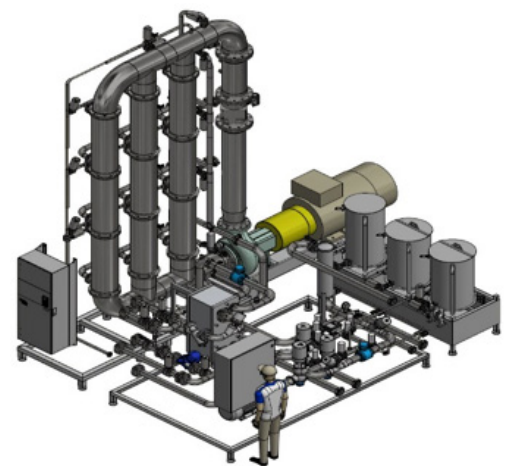


**Keraflux™-TFF System
for Yeast Management**

Keraflux–TFF System for Yeast Management

The increasing cost of raw materials and energy are forcing the brewing industry to investigate new opportunities for increasing extract yield without compromising quality. Excess yeast contains a significant amount of extract which can be recovered by concentrating the yeast with modern cross flow technology. By combining this technology with controlled diafiltration, the yield can even be boosted. The recovered beer can be blended to the original beer to a level of approximately 5 % volume without negatively influencing the quality.

Thus, beer recovery can make a big contribution to cost savings in the brewery.



Keraflux–TFF System 3x3 (above)

Benefits

- Cost reduction can include
 - Very short return on investment (ROI) of approximately 1-2 years
 - Net revenue > 90 % of the invested capital per year
 - High mechanical, thermal and chemical resistance of membranes for long module lifetime
 - Easy installation due to modular concept
 - High system availability
 - Dry matter up to 20 % for high yield
 - Low maintenance cost
 - Low operating expense (OPEX)
 - High quality yeast for sale
- Excellent beer quality
 - Minimal difference between original beer and blended beer in terms of sensory and analytics
 - Closed system for minimum oxygen uptake
 - Clear cut off with low turbidity and almost yeast free beer
- High microbiological safety due to easy cleaning and sterilization with hot water up to 90 °C (194 °F)
- Easy to extend due to modular concept
- High yield, long module lifetime, consistent beer quality and reduced energy consumption due to controlled process

Cost Reduction by Process Control

The process for yeast extract recovery uses a ceramic cross flow technology with specific control features to achieve reduced costs.

- Cost savings
 - Low consumption of cleaning agents and water
 - High system availability and production time
- Long production cycles and less cleaning cycles
 - Control of feed flow
 - Control of cross flow velocity
 - Control of permeate flow and trans membrane pressure (TMP) at each module level against target set points

Continuous adjustment of the process parameters to variable set points minimizes energy consumption and provides gentle treatment of the yeast during the entire process. Most important is the control of permeate flux and TMP in direct relation to the cross-flow speed and feed rate.

Process Description

The beer recovery is conducted in a batch process, which offers several advantages:

- Improved performance and quality due to lower yeast concentration in system during batch cycle
- Reduced energy due to lower yeast concentration in system during batch cycle
- Yield is expected to be 80 - 90% due to diafiltration

Diafiltration Principle

In this special process developed by Pall, water is added to the yeast suspension to increase the extract and alcohol recovery (wash out effect) without compromising the beer quality.

Beer IoT

To gain maximum advantage from the data generated by a PLC or Scada control system, Pall implemented IoT based digital information and process management to beer systems. With this IOT-based extension of data management in real time, different levels and hierarchies in the brewery have constant access to defined data in a user edited format.

Typical examples for digital data analytics are:

- **Specific consumption data:** e.g., water, cleaning agents, electricity, membranes,
- **Performance data:** e.g., degree of utilization, efficiency, and downtimes
- **Quality data:** e.g., oxygen uptake, original extract, haze
- **Notifications:** e.g., alarms and messages
- **Documentation and service data**

In addition to actual real time data, trends, historical reviews, brand related influences, and raw material impact, other key influencing factors can be analyzed with the IoT tool. Benchmarking with other installations within a brewery group and against the industry average is also possible and can be switched on and off.

Pall IoT provides direct online availability of all system-specific documentation and training documents, spare parts lists, service reports, operating instructions, safety instructions and acceptance reports.

Alarm messages can be displayed directly on multiple display devices, reducing response time in the event of a production problem. This function can be switched activated by each individual user, selectively.

In summary, Pall IoT solutions contribute to improve plant KPI`s, process optimization and product assurance.

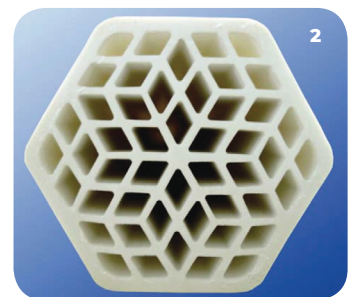
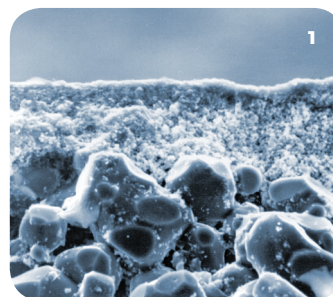
Filter Media

Membralox® Ceramic Membranes

- High flux
- Proven long operational life
- Excellent resistance to corrosion
- Wide chemical and pH (0 - 14) compatibility
- Excellent thermal stability
- Can be sanitized and sterilized

Membralox Modules

- High performance housing design and sealing assembly
- Membralox IC Modules



- 1) Cross section of Membralox ceramic membrane (x1010)
- 2) Membralox IC ceramic membranes
- 3) Membralox ceramic modules

Analytical Results and Taste Panel Data

Chemical and sensory analyses carried out by independent institutes, have shown that a back blending ratio of around 5% by volume is unproblematic. The superior quality of the recovered and blended beers has been confirmed as follows:

- No identification of blended beers by taste panel
- Minimum deviation (within analytical method sensitivity) in basic analyses
- No significant differences in esters, short chain fatty acids and stale flavor compounds
- Backed by long term experience, turbidity is typically reduced to < 0,8 EBC (90°) (*standard conditions, lager beer*)

Commercial Aspects

The short ROI with a range between 1–2 years makes this technology and the investment made into it very attractive to the brewing industry.

Example

| | Brewery A | Brewery B |
|--|--------------|--------------|
| Beer output, Sales Gravity @ 11.5 °Plato (estimate) hl/a | 1,400,000 | 8,350,000 |
| Beer output, HGB @ 16.0 °Plato (estimate) hl/a | 1,000,000 | 6,000,000 |
| Surplus yeast, 3% of HGB volume (estimate) hl/a | 30,000 | 180,000 |
| Surplus yeast, daily batch volume to process, 300 d/a (estimate) hl/d | 100 | 600 |
| Extract yield %* | 85 (80...90) | 85 (80...90) |
| Volume recovered beer, sales gravity hl/a | 36,350 | 218,100 |
| Value recovered beer, sales gravity @ 10, Euro/hl (estimate) Euro/a* | 363,500 | 2,181,000 |
| CAPEX Keraflux system and services (installation supervision and commissioning) Euro | 432,000 | 772,650 |
| OPEX Euro/hl recovered beer SG | 0.56 | 0.52 |
| OPEX Euro/annum | 20,505 | 113,950 |
| ROI/a Keraflux system and services w/o periphery/integration | 1.3 | 0.4 |
| CAPEX periphery/integration (incl. installation supervision and commissioning) Euro | 400,000 | 950,000 |
| ROI/a Keraflux system and services incl. periphery/integration | 2.4 | 0.8 |

* Depending on the type of beer and yeast

Technical Data

System Type examples:

| (Module lines x modules high) | 1x1_IC | 1x2_IC | 3x1_IC | 2x2_IC | 3x2_IC | 4x2_IC |
|-------------------------------|-----------|-----------|-----------|-----------|-----------|------------|
| Brewery size, hl/a | 1,400,000 | 3,100,000 | 4,900,000 | 6,300,000 | 9,700,000 | 12,500,000 |
| Surplus yeast, hl/d | 100 | 225 | 350 | 450 | 700 | 900 |

Base Data:

| | |
|----------------------|-------------|
| Sales gravity | 11.5 °Plato |
| HGB | 16.0 °Plato |
| Surplus yeast volume | 3% |
| Working days/a | 300 |

Process Control Solution

The units will be equipped with a state-of-the-art automation solution. Pall will cooperate with the best-established suppliers of control systems in the brewing industry. In the focus of our automation strategy are features like:

- Minimal investment costs and hardware requirements
- Easy handling and operation
- Continuous process control
- Independency of PLC manufacturer
- Modern user interface
- High level of standardization and standard software applicability
- Scalability

About Pall

Pall Corporation provides critical filtration, separation and purification solutions to meet the demanding needs of a broad spectrum of life sciences and industrial customers around the globe.



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