PALL

Food and Beverage

ENABLING A GREENER FUTURE℠

Highest Quality Yeast Extract Manufacturing with Membralox® IC Ceramic Systems

Overview

The global yeast autolysates and extracts industry is expanding dynamically, with annual market growth rates projected at over 8% from 2009 to 2015. Market drivers include the rapid growth of the processed food market. One of the main uses of yeast extract is as a natural ingredient for savory flavor creation and flavor enhancement, salt replacement, and nutritional profile enhancement of processed foods.

Fermentation is the basis of the production of yeast extract from virgin yeast cultures. After fermentation, the yeast cells are treated by salt and heat to start a self-digestive autolysis process, in which yeast cell enzymes break down the cells and cell contents are released and broken down to simpler compounds. Spent yeast from other fermentation processes such as brewer's yeast may also be used as the yeast source for subsequent treatment and autolysis.

The autolyzed yeast is then purified to separate yeast extract from the remaining cell mass. Biomass separation by centrifugation is followed by yeast extract broth clarification to remove the spent cell fragments and other suspended fines from the autolyzed yeast.

Today's yeast extract manufacturers are looking for cost-effective and eco-friendly clarification solutions that will provide high product quality and maximum yield, while ensuring process reliability and minimal waste.

The Challenge

A yeast extract manufacturer needed technology to replace old rotary vacuum drum filters (RVDF) and pressure leaf filters for yeast extract clarification after biomass separation. Diatomaceous earth (DE) filter aids used for these clarification methods amounted to several thousand tons per year. The processes were characterized by relatively high product losses. Unusable waste streams generated from the filters incurred high disposal costs. The DE was abrasive and greatly impacted equipment maintenance costs. Several dedicated personnel

Membralox ceramic system

managed the filtration equipment daily in labor-intensive operations.

To further polish the filtrate downstream of the DE filters, additional trap filtration was sometimes used. However, final filtrate quality was still variable and did not meet premium product quality requirements. In some cases, additional fining agents were required to achieve certain product qualities, however their effectiveness was variable.

For some process types, pre-concentration of the yeast broth after biomass separation was desired, however the pressure leaf filters were not effective on pre-concentrated product.

The new separation technology needed to provide optimum clarification to enable the production of premium product that could command higher market prices, while achieving maximum yield. Cost and waste reduction were key considerations, and the system of choice needed to be automated, reliable, simple to operate and robust.

The Solution

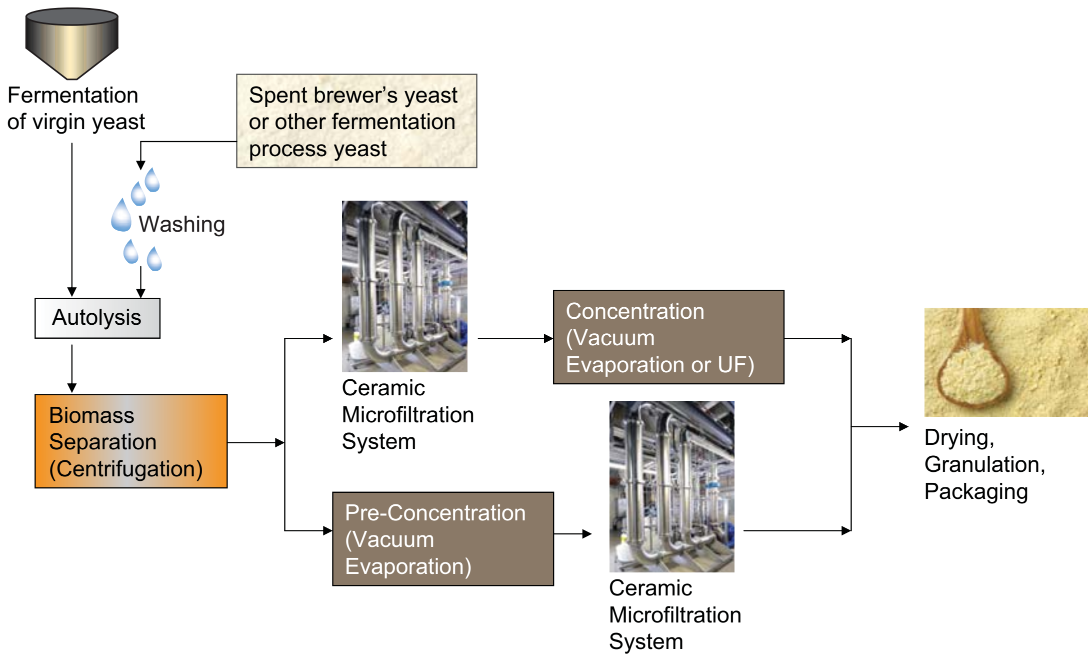
Exceptional Filtrate Quality

Membralox ceramic crossflow technology was chosen for its ability to deliver exceptional filtrate quality. Unlike diatomaceous earth filtration, membrane separation provides a reproducible, consistent barrier that will always provide a precise separation, regardless of initial broth properties or system upsets. Figure 1 summarizes the general process steps used.

In crossflow filtration, feed fluid continually sweeps across the membrane surface parallel to the filtration membrane. Separation takes place as permeate (filtrate) passes through the membrane and retentate is recirculated and concentrated (Figure 2).

The selection of the membrane cut-off is tailored to the yeast source and broth quality. For example, fermented virgin yeast is treated with 100 nmZ membranes, while spent brewer's yeast requires the tighter cut-off of 50 nmZ membranes due to a higher degree of yeast cell fragmentation.

Figure 1: Process flow diagram for yeast extract production

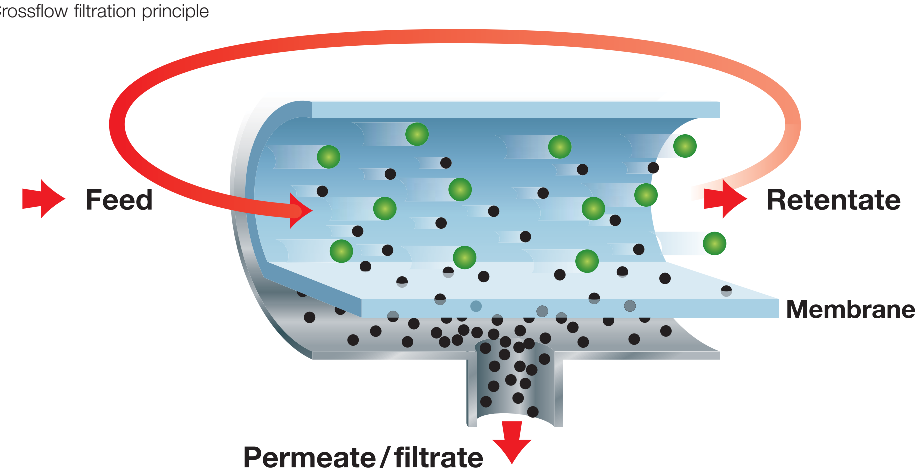


Enclosed, Filter Aid-Free Systems

The ceramic system is enclosed, limiting product exposure to the environment and potential contamination. Ceramic technology operates without the need for filter aids and their associated storage, handling, and waste disposal costs.

Workers' exposure to DE filter aids is eliminated. The retentate stream can be reintroduced into lower value process streams or dried and sold as animal feed, therefore reducing environmental burden.

Figure 2: Crossflow filtration principle



High Product Yield

Mass transfer yield into the permeate is maximized by high volumetric concentration factors (VCF) and diafiltration. In low concentration yeast extract feed fluid, spin solids are concentrated from 1% to 50% (VCF=50, up to 30% dry solids in the final retentate), with a recovery of 98%. For initially pre-concentrated yeast extract with substantially higher dry matter, spin solids of approximately 20% are concentrated to 50% (VCF = 2.5) with the benefit of additional diafiltration, resulting in a recovery of 92%.

The ability to achieve the required VCF is impacted by the size of the membrane channels. The larger the channels, the greater the ability to achieve high VCF and high permeate yield. Both 4 mm (EP48-40IC) and 5.5 mm (EP27-60IC) channels are available, and their selection is based on product concentration, viscosity and suspended solids load in the feed fluid (Figure 3).

Figure 3: Multi-channel membranes EP48-40IC *(left)* and EP27-60IC *(right)* balance the goals of optimizing highest possible VCF versus achieving highest possible filtration area.

Finally, the optimal combination of flux versus trans-membrane pressure (TMP) control during system operation provides yet another means of enhancing product recovery.

Maximized Filtration Area in Compact Footprint

Membralox IC ("intermingled channel") membranes were selected for yeast extract clarification to provide the highest membrane area in the most compact footprint. Within the same module geometry, the IC membranes with their honeycomb design enable 39-47% higher filtration area than traditional ceramic membranes with concentric ring design. The result is highly compact modules, which has a positive impact on system configuration and cost of ownership. Finally, due to the vertical arrangement of the ceramic modules, 400 m² of membrane area would result in a 20 m² system footprint.

Impact of the Membralox IC design on membrane area, module area, and system configuration (Figures 4, 5, 6):

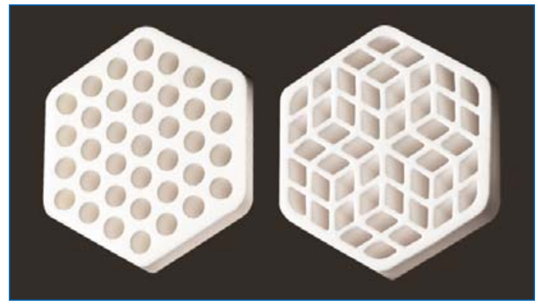


Figure 4: Membralox EP48-40IC membranes (48 channels, *right*) pack 47% higher filtration area into the same geometry as traditional EP37-40 membranes (37 channels, *left*) with concentric ring design.

Figure 5: The Membralox 36P48-40HCB module consists of 36 EP48-40IC multi-channel membranes, resulting in 24.84 m² of filtration area. A 36P37-40HCB module, by contrast, utilizes 36 EP37-40 membranes with concentric ring design, resulting in 16.8 m² of filtration area.

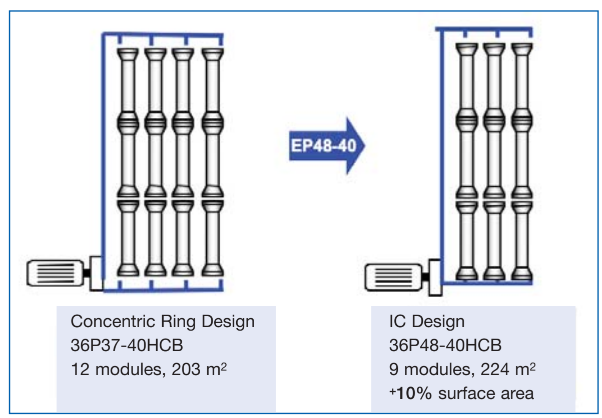


Figure 6: In this example, a ~200 m² system is configured with 9 instead of 12 modules when using the Membralox IC design, and yet a 10% higher surface area is achieved. Capital expenses (CAPEX) are reduced by 25% and operating expenses (OPEX) by 17%.

Choosing Membralox IC over traditional ceramic membrane design in this application enables:

- CAPEX savings — due to increased membrane area packed in less modules, reducing the number of modules, required loops and associated hardware
- OPEX savings — due to less hold-up volume per loop, which translates into lower cleaning water and chemical usage, reduction of wastewater volume, and energy savings

The Benefits

Membralox ceramic crossflow technology enabled the production of premium quality yeast extract at an attractive cost of ownership, due to the following factors:

- Precise membrane separation of desirable product components
- Elimination of any further filtration steps after crossflow microfiltration
- High product recoveries, on both low concentration and pre-concentrated feed fluid
- Waste and disposal cost reduction, reuse of retentate stream possible
- Labor cost reduction
- Minimal maintenance costs, elimination of DE-caused abrasion to plant equipment
- Energy savings in comparison to rotary vacuum drum filtration
- Maximum product protection due to the enclosed system
- Elimination of operator exposure to DE
- Process simplicity, reliability and safety due to system automation
- Space and cost savings due to a compact footprint

About Pall Corporation

Pall Corporation is a global filtration, separation and purification leader providing solutions to meet the critical fluid management needs of customers across the broad spectrum of life sciences and industry. We work with our customers to advance health, safety and environmentally responsible technologies.

Pall Food and Beverage provides products and services to ensure product quality and maintain process reliability in beverage and food production. Our solutions also assist in consumer protection, the reduction of operating costs and waste minimization.

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