

Filter Press Replacement with Zeta Plus™ Depth Filter Cartridges for Beer Clarification

Introduction

Filter presses have long been used by breweries in cellar operations to clarify non-pasteurized or draft beer prior to final membrane filtering and packaging. This clarification process is essential to economical membrane filtration in that beer not prepared in this manner will more quickly plug the membrane filters, leading to higher processing costs. The filter press format has been popular for many years since it is generally reliable, and the filter sheets contained in them are relatively inexpensive, commodity items. A filter press is typically composed of a series of stainless steel frames that hold cellulose-based depth filter sheets or pads. Turbid beer is pumped through the filter sheets, which retain undissolved solids, yeast, most bacteria, hazes, and other turbidity causing components.

However, as breweries modernize and review their operations, with focus on improvements in efficiency and methods of sanitation when preparing beer for bottling, many upgrade the clarification process to include more cost effective, environmentally sealed cartridge filters in place of the filter press. Deficiencies in the filter press design are well known and include: leakage of beer, exposure of the filter media and beer to contaminants in the environment, oxygen pickup, high labor and maintenance costs, and high capital costs for the equipment.

This 3M Purification Inc. Application Brief describes the benefits of an alternative method of beer clarification that employs totally enclosed Zeta Plus depth filter cartridges. Those benefits include:

- Zero leakage of beer
- Low maintenance
- Reduced labor
- Reduced disposal
- Fewer change outs
- Minimal floor space
- Decreased capital costs
- Reduced energy needs

The Process

While beer filtration processes vary according to beer style and preferences of the brewer, the schematic shown in Figure 1 is meant to serve as a generic process. Primary separation of yeast and undissolved solids is usually achieved by centrifugation and a diatomaceous earth (kieselguhr) filter. The use of fining agents and enzymes, if acceptable, assist in this operation.

Continued clarification by removal of remaining yeast, most bacteria, and haze colloids is then achieved by a filter press or by the Zeta Plus cartridge system. While these operations typically take place in the cellar, final membrane filtration is usually performed in the bottling room.

Difficulties Associated with Filter Press Operation

The following difficulties have been expressed by many breweries regarding the operation and maintenance of this style of equipment.



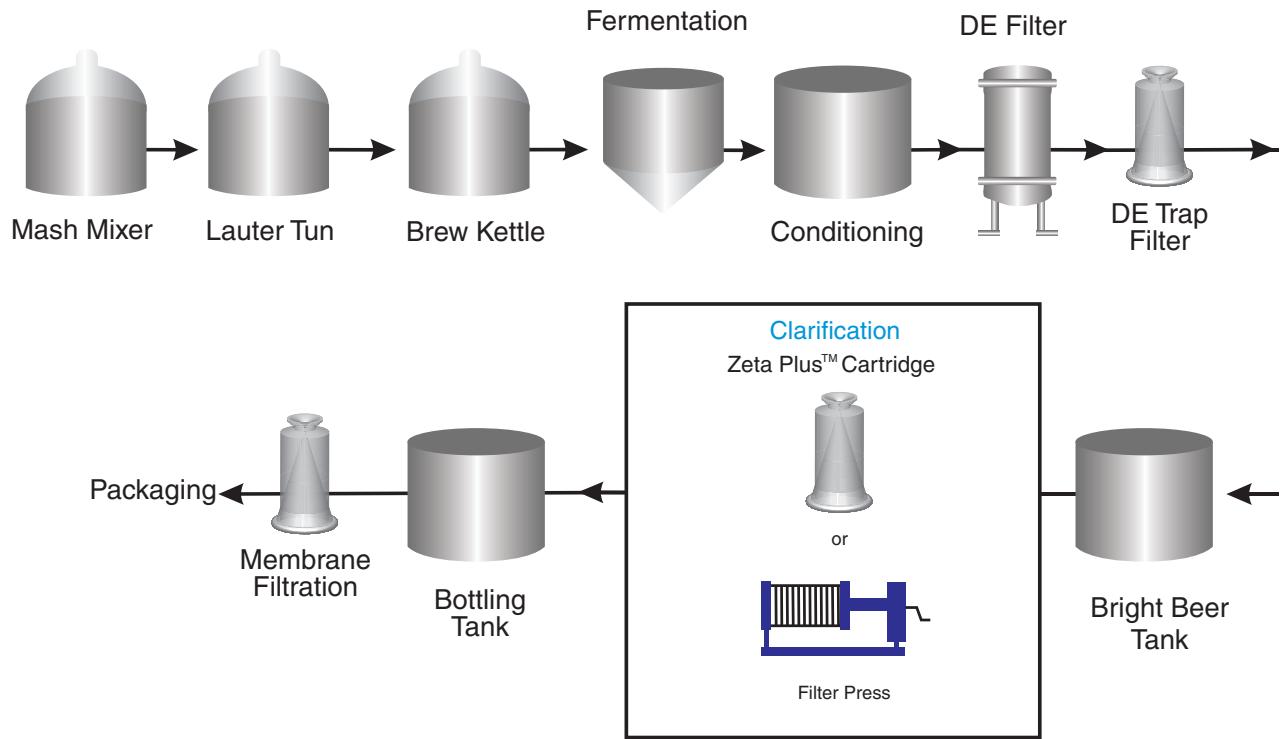


Figure 1 — Generic Non-Pasteurized Beer Process

Labor

As anyone who has changed a filter press can attest, the labor required to properly unload, clean, repack, and ready a filter press for the next filter run is substantial. Estimates range from 3 man-hours for smaller presses to up to 8 man-hours (2 operators – 4 hours) or more for larger presses.

Additionally, the awkward nature of the press arrangement and the weight of the individual plates can lead to worker injury during maintenance activities.

The yearly cost of labor can be calculated as: operators required x labor rate per hour x hours required to clean and repack the press x number of changes per month x 12.

Leakage and Beer Loss

Even new, well maintained filter presses leak some beer along the exposed periphery of the filter sheets. This beer is usually collected in a tray beneath the equipment and discarded, since oxidation and contamination occur. The leakage is accelerated in older or poorly maintained presses where seals are worn or plates are slightly warped, compromising the seals. Breweries have noted beer loss of up to 1%-2% of a given batch — a substantial cost that can be overlooked.

The yearly cost of leakage can be calculated as: liters leaked/hr x hours of operation/week x weeks of operation/yr x cost of beer/liter. The cost of the beer can be the “in process” cost associated with production, or the opportunity cost (retail price) of losing beer prior to sale in the market.

Filter Change-out

Since they are open to the atmosphere, filter sheets installed in a press are typically changed-out based on a fixed schedule, regardless of the differential pressure across the filter. Filter sheet change-out is typically conducted after a week of filtration service, although sometimes less. At that time, many breweries begin to notice mold growth along the exposed edge of the filter sheets and find it prudent to replace them. However, filtration capacity, as measured by the differential pressure across the filter press, is rarely maximized in this practice. Filter sheets are essentially removed from service and discarded without using their entire capacity to filter.

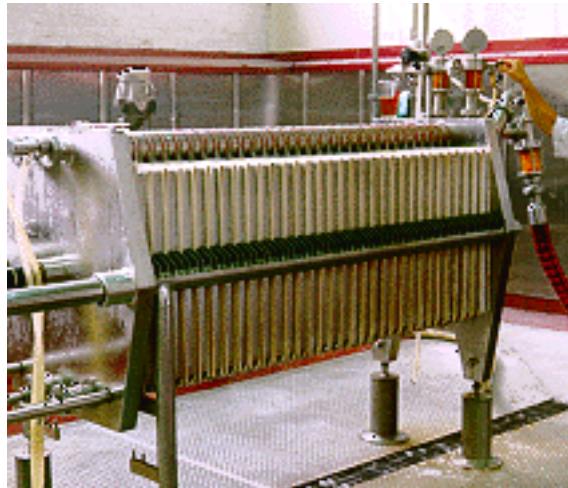


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Capital Costs

A modern, all stainless steel filter press can cost between \$10,000 for a small (40 cm² x 40 cm²) capacity press to over \$60,000 for a larger (60 cm² x 60 cm²) press. Additional hardware for automation and hydraulics can add another \$20,000 to \$30,000 to this cost. The used filter press market can offer a reduction in this capital cost, but usually at the expense of increased maintenance, and replacement parts costs down the line.

Maintenance

With a number of moving parts, o-rings, and gaskets, filter presses require considerable attention to routine maintenance for proper operation. For instance, each plate in the press typically includes 4 o-rings that need to be checked at each change-out and replaced when signs of wear are evident. Additionally, to ensure proper sealing of the filter sheets and to reduce biofilm build-up, each plate surface should be cleaned thoroughly.

The yearly cost of maintenance can be calculated as 5%-10% of the cost of the press, but can be much higher if the press is older and if other considerations are included such as the labor required and downtime of the operation while maintenance takes place.

Disposal

Since filter sheets are changed-out on a periodic basis without regard to the filtration capacity still remaining in the sheet (as measured by differential pressure across the filter press), partially unused filter sheets are sent to disposal. This increases the disposal cost. The early cost of disposal can be calculated as: change-outs per month x disposal cost of a change-out x 12.

Floor Space

Even smaller filter presses require a relatively large area for safe operation, including access from all sides and space enough to open the press entirely during maintenance operations. A 60 cm² x 60 cm² press will typically require up to 100 ft² of cellar space.

Energy

Sanitation of the filter press is usually accomplished by hot (80°C) water flushing before and after filtration. This process reduces contaminating microorganisms. Effective sanitation requires that the equipment reach the desired temperature for a minimum of 30 minutes. To be effective, timing should begin not when the water reaches the press, but when the entire system is up to the desired temperature, including all valves, drains, gauge ports and fittings. To neglect this aspect leads to incomplete sanitation, with microorganisms remaining in hard to reach areas of the filter press (behind gaskets, in bleed valves, in dead-legs). In practice, although the filter press may only be sanitized for 30 minutes at 80°C, an extended period (30 - 60 minutes) is required to get the entire filter press up to the desired temperature before sanitation can actually begin. A cost is associated with this practice as energy is required to heat the hot water. Also, downtime during the sanitation cycle is also a factor in determining the cost of this procedure.

The Solution

3M Purification Inc. developed the Zeta Plus™ depth filter cartridge system to address the undesirable aspects that most breweries experienced with filter press operation. Zeta Plus depth filter cartridges are made with the same high efficiency, high tensile strength filter media as our standard filter sheets for a filter press. However, the filter sheet media is contained in an easy-to-use cartridge form that is installed in a totally enclosed, sanitary design, filter housing.

The Zeta Plus cartridge system provides the following benefits to breweries:

Greatly Reduced Labor

Zeta Plus filter cartridges can be installed and ready for use in as little as 15 minutes, usually requiring the efforts of only a single operator. This greatly reduces the man power and downtime associated with the filter press usually by a factor of 10 or more.



Zeta Plus™ depth filters are available in 8, 12, and 16 inch diameter cartridges.

Zero Leakage

Zeta Plus™ cartridges are installed in a totally enclosed, sanitary design filter housing, eliminating beer leakage. Furthermore, the enclosed housing prohibits oxidation or microbial contamination of the beer from external sources.

Fewer Change-outs

Since Zeta Plus cartridges are installed in a totally enclosed filter housing and not exposed to the atmosphere, the cartridges can continue to be used until they reach a maximum differential pressure (35 psid), indicating that their useful life has been achieved. Depending on the nature of the beer and how well it has been prepared prior to filtration (racking, fining, D.E. filtration), a single set of cartridges can be used for weeks prior to plugging, unlike the filter press, which requires frequent change-outs.

3M Purification has also developed a warm water regeneration flushing procedure that can further extend filter service life. Documented in 3M Purification literature # LITTDCO2, this easy-to-use procedure reduces warm water soluble plugging materials from the filter, reducing differential pressure buildup and extending filter life.

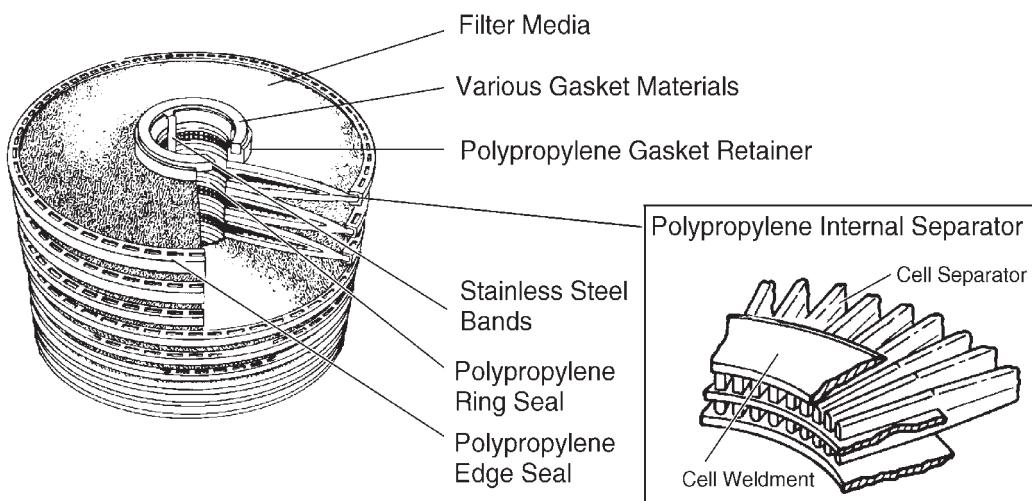
As an example, a large brewery has reported average throughputs of up to 1500 barrels per single 12" diameter Zeta Plus cartridge. Smaller, craft breweries producing all-malt, complex style beers target 250 to 500 barrels per cartridge.

Decreased Capital Costs

For equal flow rates, 3M™ series filter housings for Zeta Plus typically require from one half to a quarter of the capital cost required for an all stainless-steel filter press.

Low Maintenance

3M series filter housings for Zeta Plus cartridges have only three o-rings to maintain compared to the dozens of o-rings on a filter press. Unlike a filter press, a 3M series filter housing is easy to maintain, clean, and operate. All housing surfaces are easily accessible for cleaning. 3M series filter housings can also be fitted for optional CIP spray-balls, unlike the filter press.



Reduced Disposal

Unlike filter sheets that are changed-out on a periodic basis without regard to the filtration capacity still remaining in the sheet, Zeta Plus cartridges are only changed-out when their capacity is achieved, whether it is two weeks or a month of service. This decreases the costs incurred for disposal, sometimes by a factor of 4 or more.

Minimal Floor Space

3M™ series filter housings for Zeta Plus filters are very compact, typically requiring only a tenth of the floor space of a comparable filter press. Since the filter media in a Zeta Plus cartridge is stacked horizontally, the design makes much more effective use of floor space. This eases operator access and frees up brewery space for other operations.

Reduced Energy

The compact nature of the Zeta Plus cartridge and housing design results in much faster sanitation cycles, greatly reducing energy costs. Since the 3M series filter housing design has less stainless steel than a filter press, it can be brought up to temperature much more quickly and reliably. Additionally, the sanitary design of the 3M series filter housing eliminates dead-legs and other hard to clean areas common in a filter press that are difficult to sanitize correctly.

Conclusion and Summary

Although filter presses have been used by breweries for many years, cellar crews have noted significant deficiencies in their design and operation. The table below summarizes the benefits of the Zeta Plus™ cartridge system versus the use of a filter press for beer clarification.

	Filter Press	Cartridge	Comments
Beer leakage	Moderate to High	No leakage	Some filter presses can leak 1-2% of volume filtered.
Labor needs	High	Low	Zeta Plus Cartridge: 15 min.
			Filter Press: 2 - 4 hrs
Change-outs	Weekly or more often	2-4 weeks	Dependent on beer preparation
Capital costs	High	Low	A Zeta Plus cartridge housing is typically 50%-25% the cost of a filter press.
Maintenance	High	Low	Cartridges: 3 o-rings, Easy to clean
			Filter Press: Dozens of o-rings, difficult to clean
Disposal	Moderate	Low	Unlike filter sheets, Zeta Plus cartridges are disposed of only when filtration capacity is exhausted.
Floor space	High	Low	A Zeta Plus cartridge housing typically requires 1/10th the floor space of a filter press.
Energy	Moderate	Low	A Zeta Plus cartridge system typically consumes 1/2 the hot water and energy compared to a filter press.

Additional 3M Purification Literature

Description	Old Literature Identification	New Literature Identification
3M Purification Inc. Filter Systems for Beer Filtration	LITCATBB	70-0201-8679-0
Zeta Plus™ H Series Filter Cartridges	LITZPH1	70-0201-8856-4
3M™ ZPC/ZPB Series Filter Housings	LITHSZPBC	70-0201-8762-4
Warm Water Regeneration of Zeta Plus™ Filter Cartridges	LITTDCC02	
LifeASSURE™ BA Series Membrane Filters:	LITZRBA2	70-0201-8877-0
LifeASSURE™ Membrane Prefilters:	LITCLAFB1	70-0201-8712-9

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- Validation and Regulatory Support
- Extractable and Compatibility Analysis
- Filter System Optimization Studies
- 3M™ Series 200 Automated Integrity Testing Device

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70-0201-8673-3 REV 1211b