Filter Sheet Replacement with Zeta Plus™ Depth Filter Cartridges for Distilled Spirits Clarification

Introduction

Filter sheets installed in a conventional filter press have long been used by distilleries to clarify distilled spirit prior to bottling. The filter sheet format has been popular for many years since it is generally reliable and the filter sheets are considered to be low cost, commodity items. A filter press is typically composed of a series of stainless steel frames that hold depth filter sheets or pads. Distilled spirit is pumped through the filter sheets, which retain undissolved solids, barrel char, carbon fines, microorganisms, hazes, and other turbidity causing components.

However, as distilleries modernize and review their operations with a focus on improvements in efficiency and worker safety, many choose to upgrade the clarification process to include more cost effective, completely sealed cartridge-type filters in place of the filter press. Deficiencies in the filter press design are well known and include: leakage of distilled spirit, exposure of workers to volatile compounds like ethanol, exposure of the filter media and product to contaminants in the environment, high labor and maintenance costs, and high capital costs.

This Customer Application Brief describes the benefits of an alternative method of distilled spirit clarification that employs totally enclosed 3M™ Zeta Plus™ depth filter cartridges. When compared to conventional sheet filtration, these benefits include:

- Zero leakage of spirits
- Reduced exposure to alcohol fumes
- Reduced labor
- Lower maintenance
- Minimal floor space
- Lower capital costs

The Distilled Spirit Process

While distilled spirit processes vary according to the spirit style and preferences of the distiller, the schematic (shown in Figure 1 on the next page) is meant to serve as a generic process. Clarification is typically carried out before and/or after aging. Additional filtration steps, not depicted here, may also be involved in the process such as filtration of blending water, diatomaceous earth (DE) filtration, color standardization with carbon, final filtration just before bottling, and filtration of flavorings and additives.

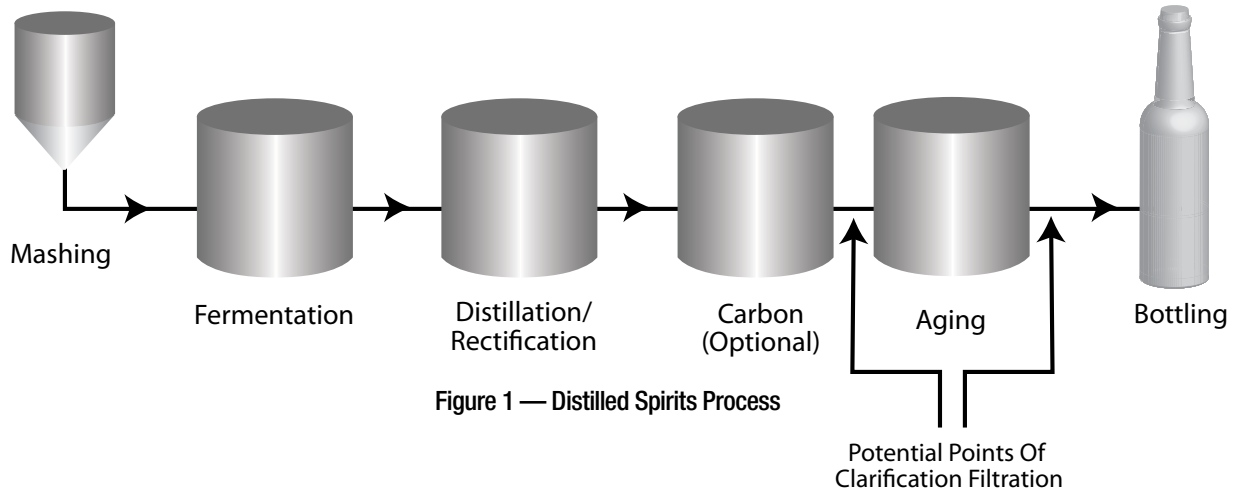

Figure 1 — Distilled Spirits Process

Difficulties Associated with Filter Sheet Operation

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

Figure 2—Typical Filter Press or Sheet Filter

Leakage and Spirits Loss

Even new, well maintained filter presses leak some distilled spirit along the exposed periphery of the filter sheets. This distilled spirit is usually collected in a tray beneath the equipment and discarded, since oxidation and contamination can occur. The leakage is accelerated in older or poorly maintained presses where seals may be worn or plates may be slightly warped, compromising the seals. Distilleries have noted spirit loss of up to 1%-2% of a given batch - a substantial cost that can sometimes be overlooked when calculating the cost of this filtration step. The yearly cost of leakage can easily be calculated as: Volume leaked/hr x hours of operation/week x weeks of operation/yr x cost of distilled spirit/volume.

The cost of the distilled spirit can be the "in process" cost associated with production, or the opportunity cost (retail price) of losing distilled spirit prior to sale in the market.

Alcohol Exposure

As explained in the preceding paragraph, in operation, distilled spirit can seep from the exposed edges of the filter sheets in the filter press. This leads not only to lost spirit, but to a condition where alcohol vapor can be present in the immediate area. Distilleries seek to develop procedures to mitigate this occurrence and support worker safety.

Labor Costs

As anyone who has changed a filter press can attest, the labor required to properly unload, clean, re-pack, and ready a filter press for the next filter run is considerable. Estimates range from 3 hours of labor for smaller presses to up to 8 hours of labor (2 operators for 4 hours) or more for larger presses. Additionally, the awkward nature of the press arrangement and the weight of the individual plates can increase the risk to worker safety during maintenance activities. The yearly cost of labor can be calculated as: Operators required x labor rate/hr x hours required to clean & re-pack press x number of changes/month x 12.

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 must be inspected at each change-out and replaced when signs of wear are evident. Additionally, to ensure proper sealing of the filter sheets and to reduce contaminant 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 down time of the operation while maintenance takes place.

Capital Costs

A modern, all stainless steel filter press can cost between $10,000 for a small (40 cm^2 x 40 cm^2) capacity press to over $60,000 for a

larger (60 cm^2 x 60 cm^2) 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.

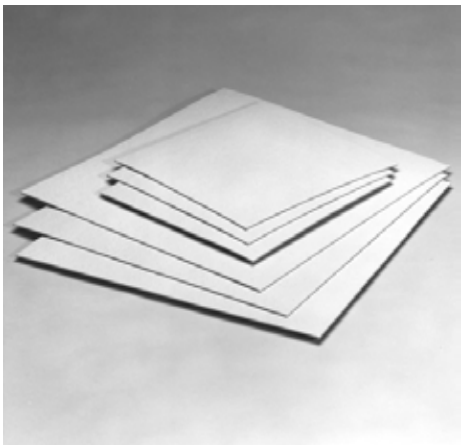

Figure 3—Conventional Filter Sheets

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 cm^2 x 60 cm^2 press will typically require up to 100 ft^2 of manufacturing floor space.

The 3M Solution

The Zeta Plus™ depth filter cartridge system was developed to address the undesirable aspects that many distilleries experience 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 designed for a filter press. However, the filter sheet media is contained in an easy-to-use filter cartridge that is installed in a fully enclosed, sanitary design, filter housing. This cartridge and totally enclosed housing design eliminates distilled spirit leakage and alcohol fumes during operation. Furthermore, compared to a conventional filters press, the design is easy to use, reducing labor, and is very compact, requiring minimal floor space in production.

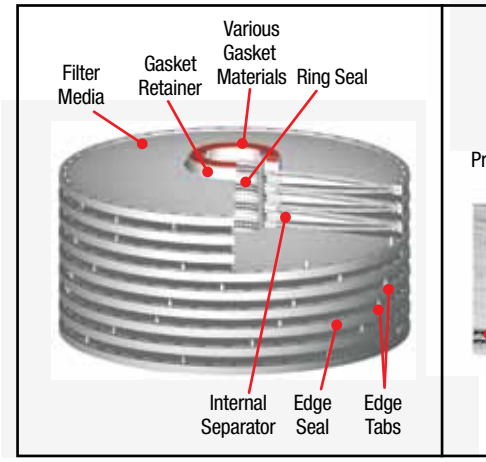

Figure 4 — Zeta Plus™ H Series Cartridge Design

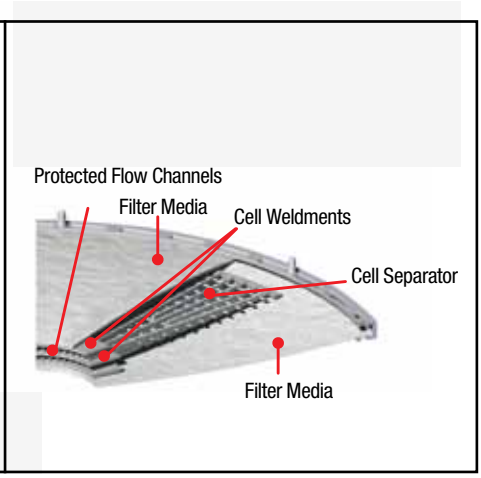

Figure 5 — Cut-away of Zeta Plus™ H Series Cartridge

Eliminating Filter Sheet Leakage

Since Zeta Plus filter cartridges are contained in a totally enclosed filter housing, there is no leakage of spirit during production and no spirit loss. This can be a substantial cost savings compared to lost spirit due to leakage from the filter press. Often times, distilleries find that eliminating this spirit loss alone will result in repayment of the initial investment in the Zeta Plus filter housing within the first year of operation.

Reduced Alcohol Exposure

The totally enclosed cartridge and housing design also greatly reduces worker exposure to both liquid alcohol and alcohol vapors, enhancing worker safety.

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 manpower and downtime associated with the filter press - usually by a factor of 10 or more.

Figure 6 — Zeta Plus™ ZPB Series Filter Housing with Dome Secured to Base

Figure 7 — Zeta Plus™ ZPB Series Filter Housing with Dome Removed to Show Installed Zeta Plus Filter Cartridges

Low Maintenance

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

Decreased Capital Costs

In new or expanding operations, Zeta Plus™ filter housings typically are 50% lower in terms of capital costs as compared to a stainless steel filter press. The Zeta Plus filter housing design employs far less stainless steel and is considerably lighter and easy to move from one location to another.

Minimal Floor Space

Zeta Plus filter housings 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 vertically, the design makes much more effective use of floor space. This eases operator access and frees up distillery space for other operations.

Conclusion and Summary

Although filter presses have been used by distilleries for many years, operators have noted considerable 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 distilled spirit clarification.

Attribute	Filter Press	3M™ Zeta Plus™ Cartridge System
Spirit leakage	Can be as high as 1%-2% of production	No spirit leakage
Exposure to fumes	Can be significant during operation	No exposure during operation
Labor	Filter change-outs can require 1 to 2 operators up to 4 hours	Filter change-outs typically require only a single operator for 15 minutes
Maintenance	Multiple seals and moving parts	Simple design, three O-rings to maintain
Floor space	Horizontal design requires significant floor space	Vertical design greatly minimizes floor space
Capital costs	Expensive (large amount of stainless steel)	Moderate (substantially less stainless steel required)

Additional 3M Purification Literature

Description	Purpose	Identification Number
Zeta Plus™ H Series Filters (single zone)	Spirit clarification	70-0201-8856-4
Zeta Plus™ H Series Filters (dual zone)	Spirit clarification	70-0201-8864-8
Zeta Plus™ ZPB Series Filter Housing	Filter housing	70-0201-8762-4
Zeta Plus™ AC Series Filters	Spirit de-colorization	70-0201-8733-5
Betafine™ XL Series Filter	Final filter – particulate	70-0201-8686-5
LifeASSURE™ BLA/BNA Series Filters	Final filter – micro	70-0201-8712-9/70-0201-8878-8
3M™ High Flow Series Filters	Water filtration	70-0201-8710-3
3M™ DF Series Filters	Barrel char removal	70-0201-8706-1

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