APPLICATION REPORT

Aspectus Filtrum Plate and Frame Filters

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The first plate and frame filters were designed in 1864 by Antoine and Simoneton in France and were made of wood. Today, the plate and frame filters used in the wine industry have stainless steel housings with plates made of 40 or 60 grade stainless steel or plastic (Noryl). Larger units, e.g. consisting of 100 filter sheets, are mainly used in the fruit juice and beer industries.

In plate and frame filters (filter press) the individual filter plates form alternate lees and clear chambers. The compaction of plates and filter sheets in the filter press creates a well-sealed system of lees compartments with an opening on the inlet side and clear chambers with and opening on the outlet side. The application of cup seals ensures that the filtration system is and remains tight. The individual filter plates are sturdy, fluted rib plates of simple and robust construction. In addition to stainless steel plates, cost-effective plastic plates have been tried and tested in wine production. In the interest of durability, the filter chassis with the fittings tends to be made of stainless steel or have stainless steel cladding.

The design of the plate and frame filter enables the filter throughput to be increased or decreased by adding or removing plates and sheets, depending on the chassis type. Larger filters with a bypass chamber have the advantage that filter sheets with different clarifying level can be used in a single operation. This enables the filtration performance to be increased right up to sterile filtration. Today, there is little difference in the design philosophy of the individual plate and frame filter. The main differences are in the materials, the configuration of the openings or windows in the plates, the passages (eyes), the fittings, the size, the frame type and the spindle closures.

Filtration with filter sheets

With optimum configuration, the two components – plate and frame filter and filter sheet – form a sealed system that can provide absolute tightness. The composition and components of filter sheets deserve closer examination. Conventional filter sheets only enable limited compression, due to a diatomaceous earth content of up to 50%. This means that problems associated with tightness are more likely in such systems. Depth filter sheets consisting of 100% cellulose fibers (BECOPAD®) are characterized by high compressibility. The plate and frame filter is tighter and forms a sealed system.

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Depth filter sheets

During the filtration the wine entering the filter simultaneously flows into all filter chambers, fills them and flows through the filter sheets, while the haze substances are retained at and in the filter sheet. The performance of depth filter sheets is generally based on the interaction of three separating mechanisms.

1. Mechanical separation:

Mechanical depth filtration retains particles within the filter sheet due to their size. The sheet is configured such that the labyrinth-like, three-dimensional structure becomes gradually finer from the inlet side to the outlet side.

2. Surface filtration:

Coarse particles and haze substances are separated directly at the surface of the depth filter sheet.

3. Zeta potential:

Depth filter sheets have an electrokinetic separating mechanism. The cationicity (zeta potential) can be adjusted through the specific composition of the depth filter sheet. When liquid flows through the sheet, very small particles with a negative charge or partial charge are retained through adsorption. The lower the cationicity of the depth filter medium, the better the flavor and color retention of the wine.

Plate and frame filters

Unlike the depth filter sheets, the plate and frame filter themselves have not yet been adapted to these technological development steps. In particular, the hygiene characteristics and configuration of the plate and frame filter have remained unchanged. With respect to hygiene, internal studies on sources of infection in wineries were carried out with the aim to examine the sterility of plate and frame filters. The bacterial contamination of a plate and frame filter strongly depends on the general state of hygiene and the tap water used. To this, end plate and frame filter were steamed and cooled with tap water, reflecting common practice. To analyze the sterility of the filter after steaming, samples of rinsing water were examined for bacterial contamination (see Table 1).

Winery	Sampling	Microorganisms
Winery I	tap water	negative
	rinsing water	Rhodotorula mucilaginosa
Winery II	tap water	Mycobacterium spec./lazari
	rinsing water	Pichia membranefaciens
Winery III	tap water	negative
	rinsing water	Rhodotorula mucilaginosa
Winery IV	tap water	fungus
	rinsing water	Rhodotorula mucilaginosa
Winery V	tap water	Microbacterium spec., Pseudomonas spec./mandelii/frederiksbergensis
	rinsing water	Kocuria carniphila, Aureobasidium spec., Rhodotorula mucilaginosa

Table 1: Results of microbiological tests of tap water and rinsing water using plate and frame filters with BECOPAD in different wineries in Germany

(source: W. Neddermann)

It was noted that micro-organisms detected in the rinsing water did not occur in the tap water. In the examined wineries (with the exception of wineries II, IV and V) the tap water was germ-free. However, in all wineries bacterial contamination with a variety of microorganisms was found in the rinsing water sample (after steaming and cooling). This indicated that the origin of the bacterial contamination in the rinsing water was not in the tap water. It seemed more likely that microorganisms were present in the plate and frame filter, and that common hygiene and sterilization measures were not adequate to guarantee full removal.

In addition, it was noted that infected tap water did not lead to reinfection of the rinsing water. This was thought to be because the composition of the microbiological flora in the examined wineries was different. In addition, none of the microorganisms that were found in the tap water were found in the wine filtrate samples.

The fact that in these tests the plate and frame filters were rinsed in the flow direction indicated that the BECOPAD depth filter sheet retained the microorganisms contained in the tap water. It was noted that the microorganisms Rhodotorula mucilaginosa and Pichia membranefaciens contained in the rinsing water were also found in wine filtrate samples. It was assumed that the other microorganisms found in the rinsing water also reached the wine but were nonviable in the wine environment.

This would indicate that the BECOPAD depth filter sheet not only retains conventional wine-damaging microorganisms, but also the microbiological load of the tap water, i.e. it offers dual protection from microbiological load. Furthermore, the test results showed that plate and frame filters that are used over many years or periodically should be cleaned and maintained meticulously, in order to avoid reinfection after the passage through the filter sheet.

The other components of the plate and frame filter also deserve attention. In many applications it is not possible to seal the plate and frame filter. A classic sign is dripping of the plate and frame filter. The tightness of the packed filter depends on three factors: the edge pressing, the gaskets, and the central pressure spindle.

1. Edge pressing – filter sheet compaction:

Edge pressing determines whether or not a plate and frame filter is a sealed system. To determine the edge pressing measure the pressing edge of 5 – 10 filter plates and calculate an average value (see Fig. 1). In addition, the total length of the plate and frame filter should be determined after pressing. The two length values form the basis for calculating the filter sheet compaction for each layer.

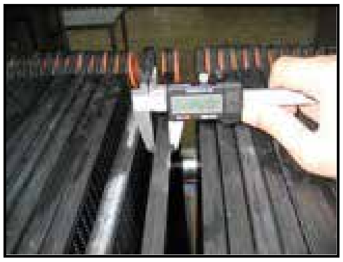

Fig. 1: Measuring the pressing edge

Fig. 2: Measuring the overall length of the packed plate and frame filter

Example:

The average width of the pressing edge of 5 – 10 filter plates is 14.15 mm. The plate and frame filter has 50 filter plates. In the application 50

Fig. 3: Filter plate with recess

Fig. 4: Warped filter plate

Fig. 5: Gasket under stress

Fig. 6: Different gasket types

BECOPAD filter sheets were used, wetted and compacted. After compaction the total length was measured (see Fig. 2). The total length of the plate and frame filter was 757.5 mm.

Calculation:

1.) Filter sheet compaction = total length of packed filter

(14.15 mm avrg. edge length x 50 filter plates)

Filter sheet compaction = 756.5 mm - 707.5 mm = 49 mm

Filter sheet compaction = 49 mm

(total length of sheet compaction of 50 BECOPAD sheets)

2.) Filter sheet compaction per sheet

Filter sheet compaction per sheer = total sheer compaction: 50 BECOPAD sheet

Filter sheet compaction per sheet = 49 mm : 50 = 0.98 mm

Filter sheet compaction per sheet: 0.98 mm

Edge pressing is an important factor for the drip characteristics of the whole plate and frame filter. The higher the compaction, the lower the drip losses. In new and well maintained plate and frame filters no dripping is identifiable. The benefits of higher compaction were taken into account in the mineral-free BECOPAD depth filter sheet. The optimum compaction for each BECOPAD sheet should be < 1.0 mm, ideally 0.8 mm. (Note: Standard depth filter have a maximum compaction per sheet of 1.1 mm to 1.3 mm).

In addition to the contact pressure, edge pressing also depends on the composition of the filter plates. Compaction is problematic with deformed filter plates (see Fig. 4), or if filter plates made of different materials (plastic) are used. Filter plates with a recess (see Fig. 3) are also unsuitable for optimum pressing.

In filter plates with inadequate recess the contact pressure is not concentrated on the edges, but distributed over the whole filter plate. This results in whole-surface compaction of the filter sheet and manifests itself by the rib structure of the filter plate being pushed down on the filter after filtration. As a consequence, the plate and frame filter is no longer sealed properly. Optimum sealing requires high edge compaction.

2. Gaskets:

In contrast to the first plate and frame filters, in which matching filter sheet types and sealing rings were identified by color, these days plate and frame filters tend to have cup seals. The advantage is that these can be used for any filter sheet type. The gasket material should be silicone or Viton. Both materials can be steamed and are available in food quality. Silicone gaskets retain their flexibility much longer than cheaper rubber or EPDM (ethylene propylene diene monomer) gaskets. The service life of silicone gaskets is approx. 3 times as high.

In practice different gaskets are used in many cases (see Fig. 6). Since the plate and frame filter gaskets are rarely replaced, they are under significant stress (see Fig. 5) and in some cases become aged and porous.

In view of the effect on compaction and the resulting drip characteristics of plate and frame filters, the gaskets should be cleaned, checked and replaced at regular intervals.

3. Central pressure spindle:

In the wine industry short central spindles tend to be used. The settings are varied with movable bridges or extension inserts. In all plate and frame filters the central spindle rod must be sufficiently long (see Fig. 7), and the spindle head and the socket must be aligned centrally with the end plate. The extension pieces are another issue. Many wineries use unsuitable extension pieces (see Fig. 8) which impair the tightness of the plate and frame filter when it is closed.

Conclusions

In summary it is clear that optimum filtration results can only be achieved through precise interaction between plate and frame filter and filter sheet. The development of the BECOPAD depth filter sheet satisfies the quality requirements of modern oenology and has already improved it significantly. In the next step the aim is to adapt the plate and frame filters accordingly. Important factors are edge pressing and hygiene of the plate and frame filter. Drip losses during filtration can be avoided, and modern filter technology is well capable of meeting today's standards (IFS/HACCP, DIN ISO) applicable to wineries.

Source: Figs. 1 – 8, Dieter

Fig. 7: Central spindle fully screwed in

Fig. 8: Incorrect, unsuitable extension piece

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