



Creating an effective wine filtration system



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Wine filtration in advanced production operations is not limited to a single filtration unit or technique. The fact is that different filter grading systems are used in various combinations in order to meet the requirements for wine quality and microbiological safety — always aiming to offer wine

consumers the best product for any occasion.

Most wine filtration systems begin with coarse filtration, which is designed solely for separating particles and large colloidal clusters. The exception is with wines that are filtered just before bottling using depth filter sheets and membrane

filter cartridges, without coarse/clarifying filtration. In this case, there is a significant risk of blockage, and filtration may stop altogether.

The most common combinations of wine filtration systems, after coarse filtration, are depth filter sheets with downstream depth filter cartridges (i.e., pre-filter cartridges) and membrane filter cartridges. The differences in these filter technologies are shown in Table 1.

To summarize the table, the main distinguishing criteria include retention efficiency, dirt holding capacity, microbiological retention efficiency and verifiability of the filtration system integrity. Filter technologies with high dirt holding capacity obviously have limited retention efficiency for microorganisms.

The various grades of depth filter sheets cover a range of applications from coarse to sterile filtration.

Filter cartridges are typically found in the final filtration stages before bottling. Depending on the size of the operation, only membrane filter cartridges or a combination of upstream depth filter cartridges and membrane filter cartridges are used. The main differences in cartridges are in the materials used, the retention rates, and the integrity testing (see Table 2).

TABLE 1: Technical and technological differences of filtration technologies

	Pre-coat filtration	Depth filter sheet	Depth filter cartridges	Membrane filter cartridges
Retention characteristics	relative	relative	relative	absolute
Dirt holding capacity	very high	high	medium to high	none
Retention capacity for wine microorganisms: wine yeasts / wine-damaging bacteria	medium to low	medium to very high (sterile)	medium to high	very high (sterile)
Verifiability of the system	no	no	no	yes

TABLE 2: Characteristic features of depth filter cartridges and membrane filter cartridges

Characteristics	Depth filter cartridges	Membrane filter cartridges
Structure	pleated or wrapped	pleated
Material (most common)	polypropylene (PP)	polyvinylidene fluoride (PVDF), polyethersulfone (PES)
Filtration mechanism	depth filtration	surface filtration
Retention rate (nominal value)	nominal retention rate: β ratio ≥ 5000 corresponds to a retention efficiency of $\geq 99.98\%$	absolute retention rate: $LRV > 7/cm^2$
Microbiological verification option	determination of yeasts (from $< 1 \mu m$ retention rate)	determination of wine yeasts and wine-damaging bacteria
Verifiability of integrity	no	yes, integrity test after each sterilization

In addition to the distinguishing features detailed in the table, depth filter cartridges have another special characteristic. In conventional depth filter cartridges, the flow is from outside to inside (see Fig. 1), but this does not have to be the case. Pleated or wrapped versions of these conventional cartridges are available.

Wrapped depth filter cartridges have individual filter layers which become increasingly finer from outside to inside. Accordingly, they are back-washable and mechanically more stable. Fig. 2 shows the flow direction of the unfiltered liquid from inside to outside. Advantages of this configuration are longer filter service life and improved system drainability, meaning that purging of the filter housing leaves little or no filtrate residue. This is ideal for filter housings with suspended depth filter cartridges, since a residual filter is no longer required. Furthermore, the use of polypropylene as a filter material ensures high chemical resistance.

A doubling of the filter area, associated with a doubling of the filter service life, can be achieved with depth filter cartridges in which flow takes place both from outside to inside and from inside to outside (Fig. 3). In other words, it combines the previous two systems in a single cartridge. It consists of an outer filter cartridge with an integrated inner cartridge (with reversed filter layer structure). The polypropylene filter material and the cartridge configuration is ideal for high filtration quantities.

The primary purpose of depth filter cartridges is to protect the membrane filter cartridges. Due to their configuration and structure, membrane filter cartridges are absolute filters and should be used as "police filters" in any wine filtration application. Also, product safety (protection against microbial secondary hazing) and economic efficiency are a key focus.

The greater the effectiveness of the particle separation and the reduction of the microbiological load through depth filter cartridges, the higher the service life of the membrane filter cartridges. This is particularly beneficial in cases where colloidal treatment agents are added shortly before bottling with filter cartridges.

Trials with different colloidal treatment agents to examine their filtration inhibition on a 0.45 µm membrane showed that colloid-free wine (black line) has an optimum filtration curve. A certain degree of filtration inhibition occurs if gum arabic (liquid product formulation, 19.2 fl oz/100 gal, 150 ml/hl) is added (data not shown). Addition of CMC (Carboxymethylcellulose, 0.67 lb/1,000 gal, 80 mg/l, blue line) and mannoprotein (3.34 lb/1,000 gal, 40 g/hl, green line) results in direct blocking of the membrane. This confirms that direct addition of CMC and mannoproteins can lead to problems, particularly with membrane filter cartridges.

Note: In the trial, various commercial treatment agents were added (30 minutes before the filtration) to a colloid-free wine that was produced via ultrafiltration. The filtration characteristics of the wine were tested at laboratory scale using the BECO® LiquiControl filter index device under constant pressure (Marx, 2010).

The upstream depth filter cartridge thus serves as a protection mechanism for the membrane filter cartridge. However, this is not the case if colloidal treatment media are applied incorrectly.

The filtration-inhibiting properties of a 0.45 µm membrane filter cartridge can be classified as follows:

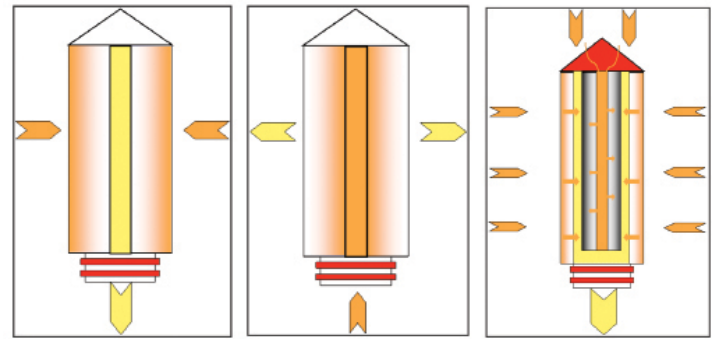
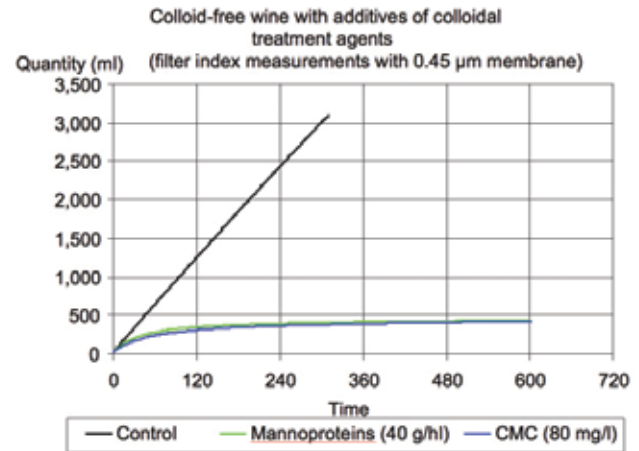


FIG. 1: Flow from outside to inside
BECO PROTECT PG
FIG. 2: Flow from inside to outside
BECO PROTECT XS XStream
FIG. 3: Flow from outside to inside and inside to outside
BECO PROTECT TS TWINStream

Orange: unfiltered wine, Yellow: filtered wine

FIG. 4: Results of filter index measurements of a colloid-free wine with different treatment agents.



Conclusion

- Gum arabic: low blocking tendency
- Mannoproteins: high blocking tendency
- CMC: high blocking tendency

Filtration problems or filtration stops during final filtration always result in significant delays and additional costs.

When colloidal treatment agents are used before the final filtration, it is therefore important to follow the recommended times of addition precisely.

The optimum combination of filtration mechanisms, including using depth filter sheets, filter cartridges and colloidal treatment agents, improves the economic efficiency of wine filtration. Retention of the wine quality can only be ensured by safe final filtration and trouble-free bottling.

Reference: Stefan Marx, Diploma student at E. Begerow GmbH from the State Research Center Geisenheim, department of Wine Chemistry and Beverage Research, Germany in 2010, Title: Influence of different clarification techniques and wine treatment agents on filtration (original German title: Einfluss verschiedener Vorklärungsverfahren und Weinbehandlungsmittel auf die Filtration.)

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