



Beco Protect® pre-filter cartridges and Beco Membran PS™ membrane filter cartridges from Eaton's filter cartridge range can be optimally combined to achieve the desired filtration result.

All Images: Eaton

The Combination is Key!

Optimum results with depth and membrane filter cartridges

In modern oenology, bottling is considered to be particularly crucial for achieving the highest quality and cost-effectiveness in the wine production process. Bottling not only includes the final quality assurance step, but also determines the quantity of wine that goes on sale. In order to meet the high market demands in terms of safety and service life, the filtration process has to function perfectly. Membrane filter cartridges are often used for this purpose. These are also known in the wine industry as „police filters“ as they retain particles and wine-damaging microorganisms (yeasts and bacteria). If a membrane filter cartridge becomes clogged, this can lead to production downtime and thus to significant loss of revenue. To avoid this, proper wine pre-filtration is essential. This prevents the membrane filter cartridges from becoming clogged early on and negatively impacting filtration performance (flux). Highly effective pre-filtration can be achieved using depth filter cartridges, for example.

The optimal combination of pre-filtration with depth filter cartridges and final filtration with membrane filter cartridges thus contributes significantly to the qualitative and economic success of the bottling process. Choosing the right

filter cartridges depends on the filtration properties of the wine, which in turn is influenced by a variety of factors. Two of the most important factors are the size and number of particles and colloids. Wine colloids have filtration-

inhibiting properties depending on their shape and size. These can range from a reduced flux rate to complete clogging of the filtration media. The particle size of wine colloids ranges from 1 nm to 1 µm with a molecular weight of 10 kilodal-

tons (kDa) to 400 kilodaltons (kDa). In studies by Vernhet et al., the effects of different wine colloids with different molecular weights on the flux rate of membranes in synthetic media and a wine-like medium of ethanol and water were tested. The authors found that, particularly in the wine-like medium, wine colloids up to 30 kDa only have a small influence on the flux rate. Only wine colloids greater than or equal to 100 kDa significantly reduce filtration performance. It can therefore be deduced that wine colloids of less than or equal to 30 kDa barely affect the good filtration properties of the wine-like medium. Media with wine colloids greater than or equal to 100 kDa should be classified accordingly as difficult to filter.

This article will analyze how the use of membrane filter cartridges and depth filter cartridges in different colloid fractions (30 kDa and 100 kDa) can affect filtration performance. The conditions under which standard membrane filter cartridges work best as the last filtration unit before bottling to fulfill qualitative and economic factors will be examined in particular. The additives of colloids such as metatartaric acid or carboxymethylcellulose (CMC) in wines that are difficult to filter are analyzed separately. Among other aspects, these were examined in a master's thesis by Fabian Wittkowsky (Hochschule Geisenheim University) and a bachelor's thesis by Ehtsham Ahmed (Frankfurt University of Applied Sciences).

Clogging indices of membrane filter cartridges

In both studies, the filterability of the wine was first determined using the BECO LiquiControl2™ index measuring device. In the tests, 1.3 gallons (three liters) of the respective wine were filled into the storage container of the device and filtered via a 0.45 µm flat filter membrane (test membrane) at a constant pressure of 14.5 psi (1.0 bar). The initial flux was measured after 0.05 gallons (200 milliliters) (F0) and the final flux after 1.3 gallons (three liters) (F3). Based on these measured values, the clogging index can be

determined using the formula $1-(F3/F0)*100$. A clogging index of 0 percent to 10 percent classifies the wine as easy to filter based on a 0.45 µm membrane filter cartridge. 11 percent to 20 percent describes moderate filtration properties and anything with a clogging index greater than 20 percent is considered difficult to filter.

In order to determine the filtration properties of wines with 30 and 100 kDa colloid fractions, the clogging index was determined for two different types of membrane filter cartridge: A PVDF membrane filter cartridge (polyvinylidene fluoride) with a symmetrical pore structure and the Beco Membran PS wine™ membrane filter cartridge made of hydrophilic polyethersulfone (PES) with an asymmetric pore structure. Both membrane filter cartridges have a standard absolute retention rate of 0.45 µm.

The tests were carried out at the Eaton Technologies technical center in Langenlonsheim with tap water (control: colloid-free version) as well as with wines containing colloids less than or equal to 30 kDa and greater than or equal to 100 kDa.

Figure 1 shows clear differences between the three clogging indices of tap water, wine with 30 kDa and wine with 100 kDa. The tap water is easy to filter and has a clogging index of 5 percent for

the PES membrane filter cartridge and 6 percent for the PVDF membrane filter cartridge. The 30 kDa wine has the lowest tendency to clog the PES membrane filter cartridge with an index of 8 percent. The PVDF membrane filter cartridge shows a higher clogging index of 14 percent. The indices of both membrane filter cartridges of 100 percent and 80 percent respectively for the 100 kDa wine sample show that this wine cannot be filtered without pre-filtration via a 0.45 µm membrane filter cartridge without directly clogging the membrane.

Pre-filtration with depth filter cartridges

The findings led to the follow-up question of how the pre-filtration of a wine that is difficult to filter (100 kDa) should be designed to achieve the optimal filtration performance of the 0.45 µm membrane filter cartridge. Various depth filter cartridges with different filter materials and different nominal retention ratings from Eaton's Beco Protect® range were analyzed. For the tests, the following depth filter cartridges were selected: Beco Protect-PG™, consisting of wrapped PP fleece with nominal retention rates of 0.3 µm and 0.5 µm and the Beco Protect FS FineStream™, made of special pleated PP fleece with nominal retention rates of 0.2 µm, 0.3 µm, 0.5 µm and 1.0 µm.

In a series of tests conducted by F. Wittkowsky, the wine (100 kDa) was

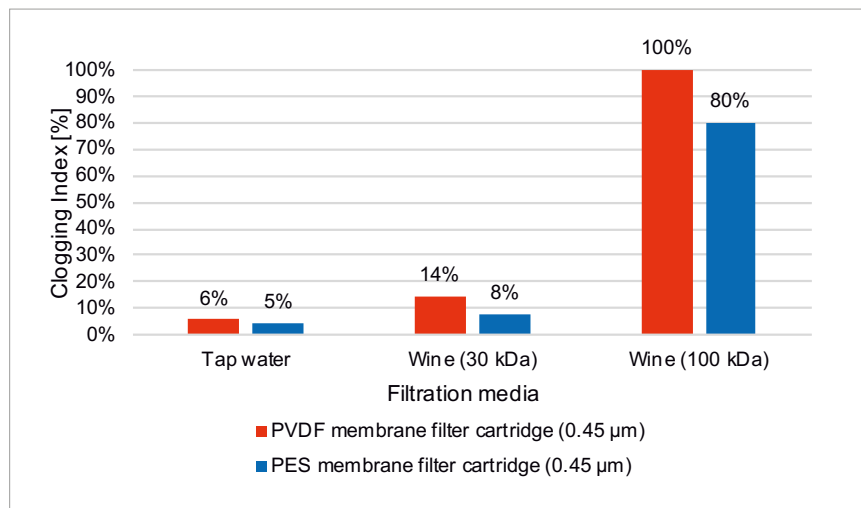


Fig. 1: Clogging indices of filtration tests comparing tap water, wine (30 kDa) and wine (100 kDa)

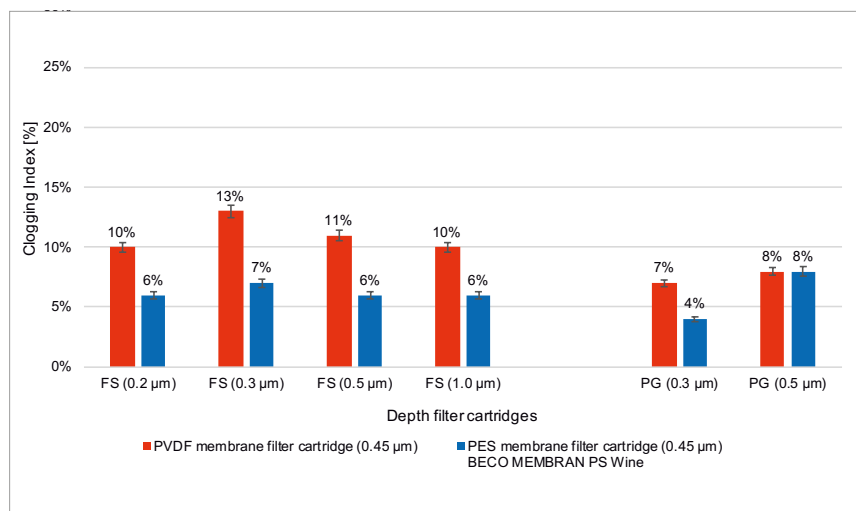


Fig. 2: Clogging indices of membrane filter cartridges after pre-filtration with various Beco Protect depth filter cartridges (wine with 100 kDa)

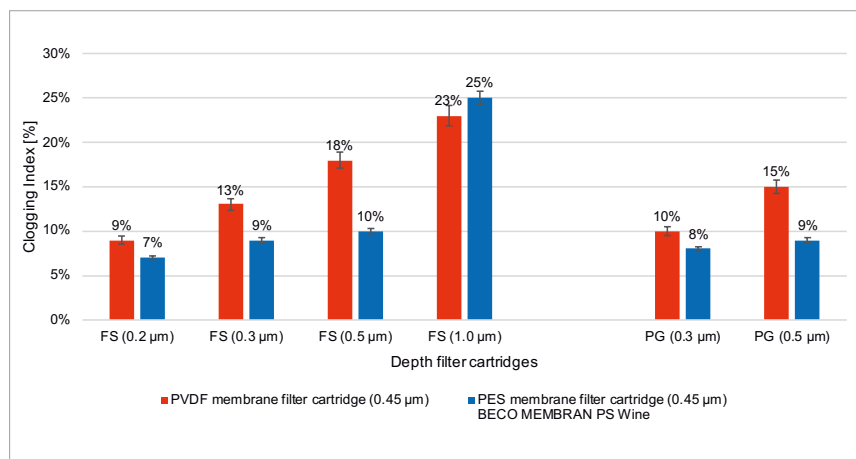


Fig. 3: Clogging indices of membrane filter cartridges after pre-filtration with various Beco Protect depth filter cartridges (wine with 100 kDa offset with 0.83 lb/1,000 gal or 10 g/hl metatartaric acid)

pre-filtered via the two depth filter cartridge types FS and PG with different retention rates. Following this, the clogging indices of the PVDF and PES membrane filter cartridge were determined.

The results shown in Figure 2 show that correct pre-filtration with depth filter cartridges significantly improves the filtration properties of wines that are difficult to filter and enables effective final filtration via a membrane filter cartridge. Regardless of the depth filter cartridge used, the PES membrane filter cartridge has lower clogging indices than the PVDF membrane filter cartridge. Only one exception can be found here: An identical clogging index val-

ue of both membrane filter cartridges after pre-filtration with the Beco Protect PG depth filter cartridge (0.5 µm).

The best test results in this experiment were achieved by the combination of the Beco Protect PG (0.3 µm) depth filter cartridge and the PES membrane filter cartridge Beco Membran PS Wine with a clogging index of 4 percent. The various versions of the Beco Protect FS depth filter cartridge (0.2 µm, 0.5 µm and 1.0 µm) follow, which in combination with the PES membrane filter cartridge come to a clogging index of 6 percent each. The best result with the PVDF membrane filter cartridge achieves the depth filter cartridge type PG (0.3 µm) with an index of 7 percent.

Clogging effects due to colloidal additives

Colloid additives such as metatartaric acid and CMC are used to ensure the tartaric stabilization of the wine. Both are protective colloids that increase the concentration of colloids in the wine. Due to its molecular structure (17 to 300 kDa) and effect, CMC has a longer protective effect than metatartaric acid, which consists of 38 percent esterified tartaric acid.

In order to investigate the influence of these two colloidal additives on the clogging index of membrane filter cartridges, further tests were conducted in wine with a molecular weight of 100 kDa. To achieve this, 0.83 lb/1,000 gal (10 g/hl) of metatartaric acid (Figure 3) and 0.07 lb/1,000 gal (8 g/hl) of CMC (Figure 4) were added to two samples. Pre-filtration using depth filter cartridges was carried out in the same manner as in the previous test (see Figure 2).

In comparison to the previous tests, the results in Figure 3 show the expected increased clogging indices by the addition of 0.83 lb/1,000 gal (10 g/hl) metatartaric acid and thus prove their influence on the filtration properties.

The PES membrane filter cartridge combined with the Beco Protect FS (0.2 µm) depth filter cartridge provides the most effective protection. Here, the clogging index is 7 percent. As with the previous test, the indices after final filtration with the PES membrane filter cartridge are lower than with the PVDF membrane filter cartridge. Only in the case of pre-filtration using the Beco Protect FS depth filter cartridge (1.0 µm) was the limit of 20 percent (wine that is difficult to filter) exceeded with 25 percent and 23 percent respectively. They were even the highest index values in the entire series of tests. The PVDF membrane filter cartridge achieved a 2 percentage point-lower index. However, with this exception, the clogging indices of the PES membrane filter cartridge are 2 percent to 8 percent below the indices of the PVDF membrane filter cartridge.

Figure 4 shows the results of the same series of tests with the addition of 0.07 lb/1,000 gal (8 g/hl) CMC. Compared to the metatartaric acid tests, five out of six clogging indices of the PVDF membrane filter cartridge increased. In one case, the value remained constant. In the case of the PES membrane filter cartridge, the value increased in two cases and decreased in two cases. In combination with the Beco Protect FS depth filter cartridge (1.0 µm), the index even fell by 10 percentage points. In two cases, the values remained constant. When compared with one another, the PES membrane filter cartridge has between 3 percent and 12 percent lower values in all tests compared to the PVDF membrane filter cartridge, which in combination with the depth filter cartridges Beco Protect FS (0.3 µm) and FS (1.0 µm) even reaches and exceeds the critical 20 percent mark. In these two cases, the downstream PVDF membrane filter cartridge does not achieve an economic service life because it clogs early on due to insufficient pre-filtration during bottling filtration.

A meaningful combination

The results of the tests demonstrate two aspects: on the one hand, the superiority of the PES membrane filter cartridge over the PVDF membrane filter cartridge, and on the other hand, the need for pre-filtration at high natural colloidal values or with manually added protective colloids such as metatartaric acid or CMC.

In the tests, the use of the PES membrane filter cartridge Beco Membran PS Wine proved to be the most efficient and therefore the most economical option. As shown in Figure 3, it achieves the lowest clogging indices for all metatartaric acid test series (with one exception). Figure 4 shows that no test series with CMC achieved the critical clogging index of 20 percent and greater. The maximum value was 15 percent. The basic prerequisite for this is the choice of appropriate depth filter cartridge for pre-filtration. The filtration properties of the depth filter cartridge

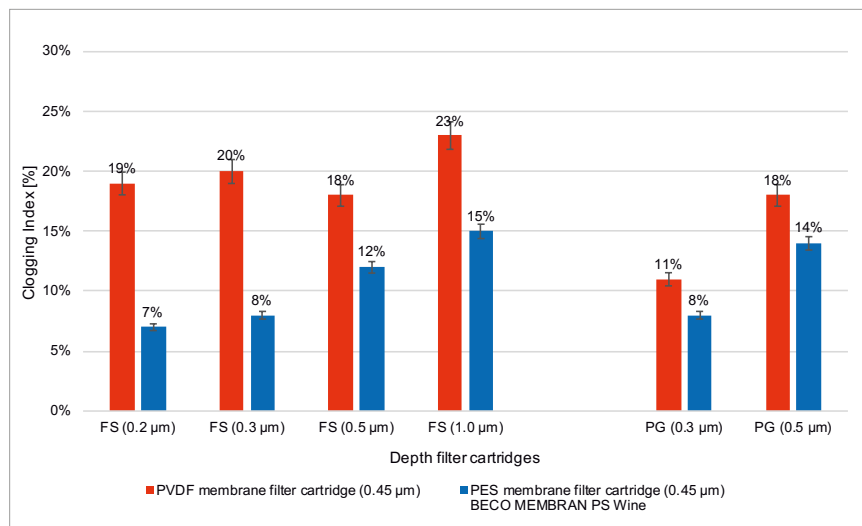


Fig. 4: Clogging indices of membrane filter cartridges after pre-filtration with various Beco Protect depth filter cartridges (wine with 100 kDa offset with 0.07 lb/1,000 gal or 8 g/hl CMC)

and the asymmetric pore structure of the PES membrane filter cartridge Beco Membran PS Wine can, when optimally combined, lead to significantly improved filtration results.

The Beco Membran PS Wine membrane filter cartridge achieved the best result with a clogging index of 7 percent when the wine was pre-filtered with the depth filter cartridge Beco Protect FS (0.2 µm). The FS depth filter cartridge achieves the depth effect with fine PP fleece, which maximizes the effective filter surface with its special pleats and at the same time keeps the differential pressure low.

Conclusion

The tests have shown that wine colloids have a significant influence on the economic success of the bottling process, as they reduce filtration performance and service life of the filter cartridges depending on their size and concentration. For well pre-filtered and easy to filter wines (< 30 kDa), the membrane filter cartridges achieve an economic service life. In the case of wines that are difficult to filter (100 kDa) and also in the use of additives such as metatartaric acid and CMC, pre-filtration with depth filter cartridges is required to protect the membrane filter cartridges from clogging early on. In the latter case, pre-filtra-

tion with the Beco Protect FS Fine-Stream depth filter cartridges was particularly effective.

Determining the clogging indices has also shown that the PES membrane filter cartridge, Beco Membran PS Wine, is particularly well suited for wine filtration. The explanation for the lower clogging index lies in the optimized, asymmetric pore structure of the membrane used, which is specifically adapted to the wine colloids. Higher wine colloid concentrations can thus pass through the filter pores and the tendency to clog decreases. During the tests, this membrane filter cartridge showed very-low to low clogging indices and thus excellent filtration performance and a longer service life compared to the symmetrical pore structure of the PVDF membrane. The PES membrane filter cartridge Beco Membran PS Wine, combined with a suitable Beco Protect depth filter cartridge, is the ideal tool to meet the qualitative and economic requirements of wine bottling. Put simply: the combination is key! ←

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