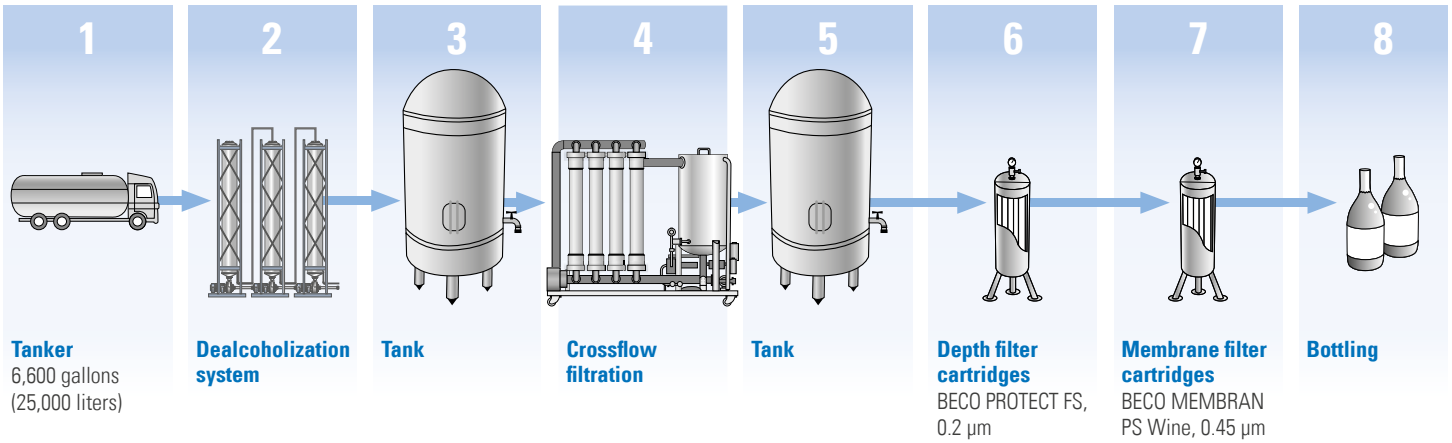


All Images: Eaton

No Alcohol? No Problem!

Alcohol-free wine presents manufacturers with challenges in filtration and quality assurance

Non-alcoholic versions of alcoholic beverages are becoming more and more popular. In addition to alcohol-free beer, the fan base for non-alcoholic wines and sparkling wines has also seen an increase. While the market share for wine is still less than one percent, sparkling wine already has a five-percent share of the market[1]—and the trend is rising. The production of non-alcoholic variants presents a particular challenge for producers since it differs considerably from the classic winemaking process. The wines are also different products in terms of the sensory experience.

Alcohol-free wine is defined as a beverage with a maximum of 0.5 percent alcohol by volume[2]. In wine, however, alcohol plays two important roles: Firstly, it is the main source of flavor, and secondly, it is an essential protective factor against microorganisms. For non-alcoholic variants, this means that the sensory and physical properties are significantly different. The beverage will be susceptible to harmful microorganisms, such as yeasts and bacteria, and therefore constantly runs the risk of becoming unstable. As a result, filtration has a distinctively important task: maintaining the microbiological stability of the alcohol-free wine until bottling and beyond.

Both the filterability and the microbiological properties of alcohol-free wines were examined as part of two master theses by Sven Horter (Hochschule Geisenheim University)* and Felix Marzolph (Weincampus Neustadt)**. The objective of these scientific papers was to determine the filter index and total bacterial count of different alcohol-free wines. In addition, the two papers examined which filtration steps would ensure microbiological stability.

Filterability and bacterial load in the production process

The production and filtration system test consisted of eight steps: from the tanker, to the dealcoholization process and subsequent tank storage, then to the filtration process with crossflow storage filtration (CFF), intermediate tank storage and two-stage fine and final filtration. The latter consisted of Beco Protect® FS depth filter cartridges with a nominal retention rate of 0.2 µm followed by Beco® Membran PS Wine membrane filter cartridges with an absolute retention rate of 0.45 µm.

For data collection, samples were taken from the tanker, after passing through the dealcoholization system, after CFF and after the two-stage cartridge filtration, and then analyzed. To identify the filterability via a filter index, a Beco LiquiControl2™ index measuring device was used. In this process, 0.85 gallons (3.2 liters) of the respective wine were added

to the device's storage container and filtered using a 0.45-µm flat filter membrane (test membrane) at a constant pressure of 14.5 psi (1.0 bar). Based on the measured filtrate quantities, the wine can be classified as either "easy to filter" with a filter index value of ≥ 3,000 ml, "average filterability" with a filter index value of 2,500–2,999 ml or "difficult to filter" with a filter index < 2,500 ml.

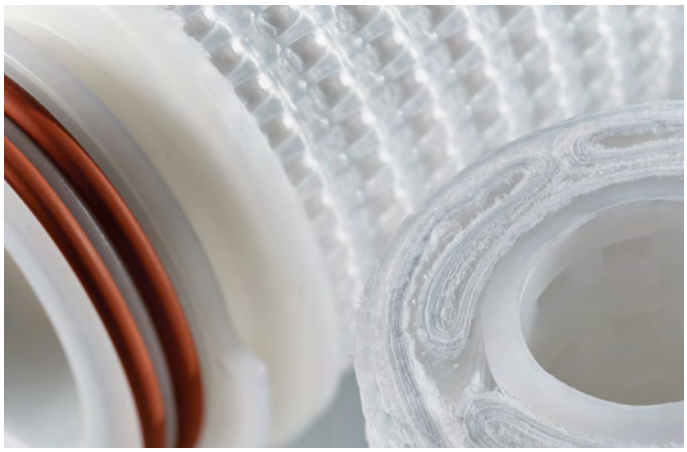
The microbiological tests of the samples were carried out in a laboratory using membrane filtration. The sample was filtered using a 0.45-µm flat filter membrane under sterile conditions and then incubated on different culture media in agar plates. The growth of microorganisms that could contaminate the beverage, such as yeasts and bacteria, was counted after a defined incubation period of five days at a temperature of 81°F (27°C). A sample is defined as sterile when zero colony-forming units (CFU) per ml are analyzed. At a value of > 100 CFU/ml, a sample is considered to be highly contaminated with microbes, and at a value of > 200 CFU/ml, the beverage is considered to have a very high bacterial load. In this case, it is no longer possible to count the content of the agar plates, as the colonies are already overgrown.

Initially, four different wines with a volume of 6,600 gallons (25,000 liters) each were analyzed: a German red wine, a German white wine, a Spanish Merlot and a Spanish Cabernet Sauvignon. The following table shows the filter index measurements and cell number determinations for the four wines.

This revealed that three of the four wines were already classified as "difficult to filter" following the initial sampling from the tanker. Only the German white wine achieved a filter index of 3000 ml and was therefore "easy to filter". Again for all of the wines, the filter index fell significantly to values between 200 and 693 ml following dealcoholization. The CFF allowed the two German wines to attain a filter index of 3000 ml, while the index value of the Spanish wines increased only slightly and remained "difficult to filter". It was only through the combination of depth filter cartridges and downstream membrane filter cartridges that all wine batches could achieve a filter index of 3000 ml and be classified as "easy to filter".

Notably, during the microbiological tests, high (> 100 CFU/ml) to very high (> 200 CFU/ml) microbiological loads were observed in three of the wines when they were delivered to the tank. Only the Spanish Cabernet Sauvignon demonstrated a lower cell count of 50 CFU/ml. After dealcoholization, all of the wines were subject to very high loads of > 200 CFU/ml. It was only following the two-stage cartridge filtration that the microbiological load of all of the wines could be reduced to the sterile range of 0 CFU/ml, meaning that no yeast and bacteria that could contaminate the beverages could be re-introduced.

In a further test using 6,600 gallons (25,000 liters) each of a Spanish Merlot, French Chardonnay and European Rosé, the microbiological results with regard to bacterial load were confirmed (see Table 2). Although the load for the Chardonnay and the Rosé decreased after dealcoholization, they still exhibited high values of > 100 CFU/ml. For the Merlot, the load was very high throughout the entire production process. It was only following the two-stage cartridge filtration that the colony-forming units were able to be reduced to zero, allowing for a sterile bottling process for the alcohol-free wines.



Due to their innovative pleating, Beco Protect FS depth filter cartridges offer a large filter surface with high retention rates. This means that they are especially suitable for protecting downstream membrane filter cartridges in beverage filtration.

Beco Membran PS Wine membrane filter cartridges have been specifically developed for the final filtration of wine and sparkling wine. Due to the high-quality polyether sulfone membranes, they also meet the requirements for the microbiological stability of alcohol-free beverages.

Sampling point	German red wine		German white wine		Spanish Merlot		Spanish Cabernet Sauvignon	
	Filter index [ml]	Cell count [CFU/ml]	Filter index [ml]	Cell count [CFU/ml]	Filter index [ml]	Cell count [CFU/ml]	Filter index [ml]	Cell count [CFU/ml]
Tanker	622	> 100	3,000	> 200	927	> 200	450	50
After dealcoholization	200	> 200	693	> 200	323	> 200	250	> 200
After CFF	3,000	> 200	3,000	> 200	675	> 200	638	> 200
After two-stage cartridge filtration	3,000	0	3,000	0	3,000	0	3,000	0

Tab. 2: Results of identifying the total cell count; Comments: All values in CFU/ml; CFU: colony-forming units; > 100: more than 100 CFU/ml; > 200: CFU/ml no longer countable, overgrown

Sampling point	Spanish Merlot	French Chardonnay	European Rosé
Tanker	> 200	> 200	> 200
After dealcoholization	> 200	> 100	> 100
After CFF	> 200	> 100	> 100
After two-stage cartridge filtration	0	0	0

Tab. 1: Results of the filter index measurements and the total cell count; Comments: CFU: colony-forming units; > 100: more than 100 CFU/ml; > 200: CFU/ml no longer countable, overgrown

Impossible without them—two-stage fine and final filtration with depth and membrane filter cartridges

As the test results show, the production process of alcohol-free wine is a particular challenge in terms of filterability and microbiological stability. The removal of the alcohol significantly reduces filterability—even the German white wine delivered as "easy to filter" only achieved an index value of less than 700 ml once the alcohol had been removed. A wine that is difficult to filter can easily become a cost factor for producers. The more difficult the wine is to filter, the easier it is for the membrane filter cartridges to become clogged. This then leads to more frequent cleaning or filter replacement. During this time, machines are at a standstill and the bottling is delayed.

In addition, the non-alcoholic wine loses its protection against microorganisms that could contaminate the beverage, such as yeasts and bacteria. A contamination value of > 200 CFU/ml indicates a very high bacterial load. This was detected in a large number of samples. It can be concluded that manufacturers must set in place especially stringent sanitary requirements for filtration systems if the alcohol is missing as an inhibitor. This is the only way a microbiologically stable wine can be bottled and to prevent the secondary fermentation and sensory changes caused by microbiological activity within filled bottles.

This series of tests has shown that the CFF process was unable to achieve sterile levels in any sample. In terms of filterability, CFF proved helpful for some of the samples, but was not sufficient for all of the wines analyzed. It was only possible to obtain sterile wines following two-stage fine and final filtration using depth and membrane filter cartridges. The depth filter cartridges retained the majority of the particles and microorganisms, while the downstream membrane filter cartridges, so-called "police filters", ensure microbiological stability. This two-stage fine and final filtration is absolutely essential for the production process of alcohol-free wines. It is the only way to ensure the microbiological quality and sustainable marketability of the alcohol-free beverage, and therefore to offer quality assurance of the highest level. ←

1 Loose, Simone (2017): Zwei viertele mehr. Trinkweinbilanz. (Two quarter liters more. Wine balance.) In: Der deutsche Weinbau (Specialist wine manufacturing magazine) (19), p 28–31

2 Weinverordnung (German wine regulation) version from 05/03/2021, section 47

* Horter, Sven, 2019. Filtration von entalkoholisierten Weinen (Filtration of alcohol-free wines). Master thesis, HS Geisenheim University, Justus-Liebig-Universität Gießen

**Marzolph, Felix, 2019. Economical evaluation of filtration in alcohol-free wine production. Master thesis, University of Business and Society Ludwigshafen, Weincampus Neustadt

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