Employing Microporous Membrane Filtration to Help Control Microorganisms in Bottled Spring Water Production

Introduction

Over the last decade, the popularity of bottled water has surged in many countries. Consumers are drawn to the convenience, taste, and health attributes that bottled water provides. To meet these customer expectations, many bottled water companies employ a number of filtration steps in spring water production. These steps are designed to maintain the high quality of the product water during the bottling operation and to ensure an attractive appearance and taste for the customer.

Common initial filtration steps involve reducing the number of visible particulate that may be present in the water as it flows from the spring as well as any particles generated by other activities during the bottling process. Unwanted particles can be generated in tanker trucks or piping used to transport the water to the bottling plant, in the holding silos used to store the water, or in carbon, sand or multimedia beds used to process the incoming water.

Increasingly, spring water bottlers are installing additional operations at the final bottling stage to help control microorganisms that are naturally present in the water. However, some common strategies, such as ultraviolet light (UV) or ozonation, can have certain limitations. For instance, the efficiency of a UV lamp can be impacted by the strength of the light source over time, the cleanliness of the contact chamber, and by the presence of particles in the water that can "shadow" microorganisms, thereby shielding them from the UV light. Ozone, while a powerful oxidizer of microorganisms, can also lead to increased maintenance costs of downstream materials such as seals and gaskets, precipitation of manganese and iron oxides in the water, and the conversion of bromide (if present in the source water) to bromate in concentrations above allowable limits.

Another alternative, the use of microporous membrane filters designed to reduce microorganism content in the water, is explored in this Application Brief. Microporous membrane filters, along with a rigorous plant hygiene plan, can either be used alone or supplemented with additional methods of microorganism control such as UV or ozonation, as part of a "multi-barrier approach" to water quality.

Microporous membrane filters:

- Are fixed barriers against microorganisms, with a defined retention rating.
- Leave the taste and appearance of the water unchanged.
- Provide additional turbidity control in the process.
- Have low energy consumption compared to alternative methods of microorganism control.
- Are easy to use and have a low, fraction of a cent-per-gallon running cost.
- Are integrity testable by the user to ensure they are installed and operating correctly.

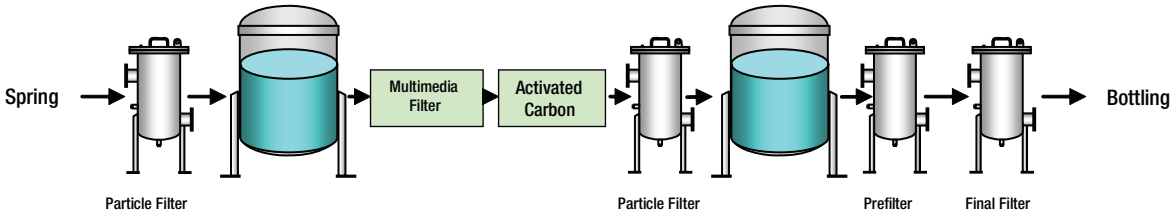

Figure 1 — Typical Spring Water Process[1]

The Problem

Most natural spring water sources contain modest levels of bacteria generally categorized as Heterotrophic Plate Count bacteria, or HPC bacteria. These organisms are benign, cause no known adverse health affects, and their levels are within most local standards for potable water – in fact, they are just as commonly found in tap water.

However, some bottled water companies have concluded that the presence of any bacteria in their final product is not compatible with their brand image. Additionally, it is believed that the presence of bacteria in the water can partially be attributed to biofilm growth on surfaces in the processing plant. Biofilm consists of complex associations of microorganisms held together in an extra-cellular matrix of excreted materials that attach to surfaces like stainless steel piping via an adhesive-like material. Proper cleaning and sanitation protocols go a long way to help reduce the formation of these biofilms. However, the sheer amount of surface area available to them, as well as the ability of microorganisms to adapt and propagate in micro-crevices and other hard to reach areas of the process (such as behind gaskets, valve seats, threads, etc.), usually results in a continued presence of bacteria in the product water.

Greatly reducing these bacteria through a rigorous cleaning and sanitation plan, coupled with 0.2 micron absolute rated microporous membrane filtration, is considered indicative of robust plant hygiene. While not all bottled water companies employ 0.2 micron rated final membrane filters, their popularity is increasing around the globe.

The CUNO® Solution

The BevASSURE™ BDA020 series microporous membrane filter helps bottled water and other beverage processors meet the highest standards for microorganism control. The BevASSURE BDA020 series filter combines three CUNO technologies, resulting in a robust filter optimized for both long service life and fast flowing applications that provides 0.2 µm absolute rated filtration for sterilizing grade performance.

1 Schematic is intended as a guide only. Water treatment options and filter positions can vary by company and the nature of the water.

Advanced Technologies

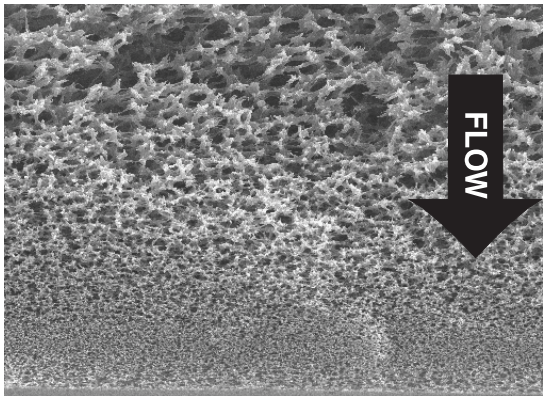

Figure 2 — SEM Photograph Showing BevASSURE PES Membrane Cross-Section

The first technology is a double layer of highly asymmetric Polyether Sulfone (PES) membrane (refer to Figure 2). When viewed in cross-section, the membrane contains larger pores on the upstream surface that gradually taper to smaller pores toward the downstream surface. Compared to conventional membranes with symmetric pore structures, this structure provides greater contaminant capacity, since it presents greater open spaces (void volume) in which to retain these contaminants. This increase in capacity leads directly to longer service life. In addition, the asymmetric structure provides less resistance to flow, resulting in a lower pressure drop when compared at a constant flow rate to competitive filters, allowing a user to employ fewer BevASSURE™ PES filters for any given flow rate.

The second technology is the patented Advanced Pleat Technology (APT). This design technology maximizes the *useful* surface area of the filter while maintaining open flow paths between the media pleats (refer to Figure 3). By employing the APT design, the BevASSURE BDA020 filter provides lower pressure drops, longer service life, and lower overall operational costs.

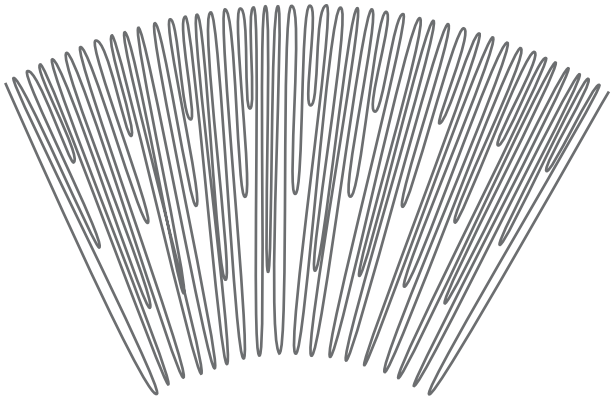

Figure 3 — Advanced Pleat Technology Design

Lastly, BevASSURE BDA020 filters employ a patent pending design that results in higher beverage flow versus pressure drop compared to competitive filters. This unique CUNO development combines the high flowing PES membrane with special support layers upstream and downstream of the membrane. When combined with the previously mentioned Advanced Pleat Technology, this feature greatly increases flow per cartridge and results in lower overall operational costs.

Process Benefits

There are a number of benefits that result from these technologies. First and foremost is bacteria retention. BevASSURE PES 0.2 micron rated filters provide superior retention of common microorganisms, even at challenge concentrations that far exceed those experienced by most beverage producers. BevASSURE BDA020 membrane has demonstrated complete retention of *Brevundimonas diminuta* (ATCC 19146) and *Pseudomonas aeruginosa* (ATCC 14502) at a concentration of 10^7 CFU/cm^2 or greater.

Microorganism	Average Microorganisms Entering Filter	Average Microorganisms Exiting the Filter
Brevundimonas diminuta	10^7 CFU/cm^2	0
Pseudomonas aeruginosa	10^7 CFU/cm^2	0

The three key technologies in the BevASSURE BDA020 series filter also result in superior filter cartridge flow rates versus differential pressure drop characteristics when compared to similarly rated filters. This can be beneficial in two ways:

For existing systems with fixed flow rates (for instance, limited by the speed of the existing filling machine), the BevASSURE BDA020 series filter will exhibit a lower initial pressure drop. Since microporous membrane filters are typically changed based on achieving a preset terminal differential pressure drop (usually between 25 psid and 35 psid), filters with lower initial pressure drops usually will last longer and process more water before change-out.

For new systems, the fast flow properties of the BevASSURE BDA020 series filter allows for smaller filter vessels containing fewer filter cartridges, resulting in lower installation costs.

Prefiltration Options

Many bottling applications employ a prefilter and final filter in series to achieve maximum performance and economy. Prefilters are used to help protect and extend the life of the more expensive final filters. CUNO offers two premium prefilter choices: Betafine™ XL pleated polypropylene filter cartridges and PolyNet™ depth polypropylene filter cartridges. Betafine XL filter cartridges[2] feature our patented Advanced Pleat Technology maximizing the accessible filter area and supplying exceptionally high flow rates and excellent downstream microporous membrane filter protection. Those preferring depth-style filters can select from the CUNO PolyNet prefilter family[3] which employs an advanced media design that enhances flow while extending service life.

Filter Recommendations (Please refer to Figure 1)

Application	Filter Recommendation	Micron Rating
Spring load-out particle filter	CUNO® High Flow, or PolyKLEAN™	1 – 5 µm
Post-carbon particle filter	CUNO® High Flow, PolyKLEAN™, or PolyNet™	1 – 5 µm
Prefilter	Betafine™ XL, or PolyNet	0.5 – 2 µm
Final Filter	BevASSURE™	0.2 µm

Conclusion

The popularity of bottled water continues to rise around the globe. As part of a rigorous plant hygiene plan, and consistent with tightening quality specifications, many spring water bottlers are installing additional operations at the final bottling stage to help control microorganisms that are naturally present in the water. Some common strategies when used alone, such as ultraviolet light (UV) or ozonation, can have certain limitations. Microporous membrane filters, such as the BevASSURE BDA020 series filter, have been shown to be an effective means to help bottlers control microorganisms in the product water. BevASSURE BDA020 filters provide consistent, high levels of microorganism retention, while minimizing running costs.

2 For more information, refer to Betafine XL Data Sheet (Literature Identification LITCBFXL)
3 For more information, refer to Polynet Data Sheet (Literature Identification LITCPN1)

70-0202-0738-0
LITCABBA1.0608

CUNO®
a 3M company

CUNO Incorporated
400 Research Parkway
Meriden, CT 06450, U.S.A.
Tel (800) 243-6894
(203) 237-5541
Fax (203) 630-4530
www.cuno.com