



Application Bulletin

TAB Filtration Significantly Improves Ready to Drink Tea Quality and Yield

Overview

Ready to drink tea, fruit juices and drinks, carbonated soft drinks, and other beverages are subject to spoilage due to the presence of heat-resistant, acidophilic bacterial spores (TAB). The thermoacidophilic spores may originate either from exposure to agricultural raw materials such as in fruit juice production, or from contamination in the beverage ingredients, such as sweeteners, juice and tea concentrates, or flavors, essences, and colors from natural extracts. These TAB spores comprise *Alicyclobacillus* species of several types, including *A. acidoterrestris*, *A. acidocaldarius*, *A. herbarius*, *A. acidophilus* and others. Their introduction into the right fluid environment for germination and microbial growth results in final beverage quality degradation, due primarily to formation of distinctive off-flavors and odors.

Unfortunately, spoilage is not usually obvious because TAB organism growth does not produce gas, and the problem may be unrecognized until consumer complaints are received.

The spores are highly resistant to heat treatment, UV radiation, disinfectants, and extreme pH values. Therefore even the application of preservation methods for the beverages, such as pasteurization, is often not sufficient to provide spore-free product. Extensive heat treatment would be necessary to kill these spores, however such treatment may negatively influence product attributes such as flavor, color and nutritional value, and may be cost- and energy-intensive.

Alicyclobacillus species, even if non-pathogenic, cause serious economic damage for beverage producers. They are difficult to control once in the processing environment. Specifications for the ingredient vendors may therefore include the requirement for TAB spore-free product.

Filtration technology that enables spore removal from the ingredients or from beverages is an ideal solution for this challenge.



Pall MEMBRACart XL II Filter Cartridges

The Challenge

A beverage manufacturer creates a variety of flavored ready to drink teas. They are a national brand with wide distribution, shipping 5 million liters (1.32 million US gallons) per year to their customers.

The manufacturer extracts tea from tea leaves from varying foreign sources. From time to time, they found TAB spores in the tea, which negatively impacted the quality of their end products and resulted in having to discard the affected batches. At a value of US\$ 85,000 per batch of finished product, the financial impact was high and a solution was required.

The manufacturer's goal was to find an integrity-testable filtration solution that would guarantee final tea quality and eliminate product losses.



The Solution

Pall MEMBRACart XL II (0.45 micron) membrane filter cartridges and a Palltronic® Compact Star integrity test device were selected to meet the need for TAB spore removal and filter performance monitoring.

After hot water steeping of the tea leaves, the extracted tea is clarified with a crossflow microfiltration system, then cooled. Final membrane filtration for removal of the TAB spores follows. The resulting filtrate batch is monitored for quality, and if it passes QA requirements it proceeds to further downstream processing steps including ingredient addition, mixing, pasteurization and filling.

The MEMBRACart XL II filter family of products is used extensively in the beverage industry to provide secure and reliable removal of spoilage microorganisms in a variety of applications. In particular, the 0.45 micron MEMBRACart XL II option has been validated for removal not only of the model spoilage organism *Serratia Marcescens*¹, but also for TAB spores² (Figure 1).

Extensive laboratory studies involving microbial challenge tests show that these filters provide complete retention of TAB spores in different fluids evaluated under defined test conditions. When challenged with *A. Acidoterrestis* spores at a challenge level between 10^5 and 10^6 /cm² of filtration area, the 0.45 micron polyethersulfone (PES) membrane demonstrates a log reduction value (LRV) of greater than 7 in an acidified fluid model (apple juice) and greater than 7.8 in a high viscous fluid model (corn syrup). It is important to note, that any microbial rated filter should be accompanied with robust validation test work and documentation, as a micron rating in and of itself does not guarantee proper outcomes.

In the tea application, the MEMBRACart XL II filters have performed consistently as expected, yielding zero TAB spore counts in the tea product. This result is confirmed with each tea batch by means of a microbial culture method for presence of TAB vegetative cells and spores³.

The filters can be repeatedly steamed in place (SIP) and hot water cleaned, without compromising their robustness or removal performance. At the tea drink producer, the filters are steamed in place prior to first use, with a typical sterilization regime of 121 °C (250 °F) for 20 minutes. After air cooling, filtration begins. At the end of the batch, the filters are flushed with cold water, then re-steamed, cooled and stored within the filter housing under carbon dioxide pressure until next use. With each reuse, the filters are first steamed in place and cooled prior to filtration. Given this protocol, the tea drink producer is able to achieve up to 320 steaming cycles in this application. The filters typically last up to four months, exhibiting a throughput of 140,000 liters (37,000 US gallons) of tea per 30 inch cartridge. The extremely long service life drives down filtration-related operating expenses such as disposable filter spend, water, cleaning chemicals, and labor, and it reduces process downtime.

To confirm membrane filter performance, a Palltronic Compact Star filter integrity test instrument is used both prior to and after completion of each filtration batch (Figure 2). The Pall Compact Star is a simple to use, portable device based on the principle of pressure decay integrity test. Results can be printed or downloaded to supplement Quality Assurance records.



◀ Figure 1: *Alicyclobacillus* species are gram positive, thermoacidophilic spore-forming bacteria which cause serious economic damage for beverage producers.



With the Pall solution, the customer's disposable filter spend represents about 0.02% or a fraction of the value of the production. Additional operating costs related to cleaning and sanitizing operations, and labor for filter change-out are negligible when considering the disproportionately high benefit of securing product quality and maximizing yield.

Quality Monitoring for TAB Contamination

As processes increase in size and complexity, a manufacturer's risk of exposure to economic loss due to quality insufficiencies increases. Robust and high performing filtration techniques deliver desired outcomes, however an integrated quality assurance program that monitors critical control points in the process is indispensable.

Every step of the process, from raw material receiving to final packaging and managing utility fluids (e.g. water) is a potential point of unwanted microbial contamination. Pall's GeneDisc® Real-Time PCR system is a rapid, sensitive, and reliable easy to use detection and identification method for TAB spoilage bacteria, yielding results in a matter of hours. This quick confirmation tool for product quality not only reduces time to shipment, but also provides informative monitoring with which processors can diagnose or prevent problems at the different critical control points of a process³.

The Benefits

With the MEMBRACart XL II and Palltronic Compact Star solution, the tea drink producer has achieved its goals, realizing these benefits:

- Brand protection, due to consistent production of TAB spore-free product with validated filtration performance
- Increased product yield due to total elimination of TAB-contaminated batches
- Preservation of organoleptic product quality
- Low filtration operating costs due to long filter service life
- Monitoring, assurance, and documentation of filter performance with simple integrity test



◀ Figure 2: Palltronic Compact Star is a simple to use, portable test device used to monitor and document filter integrity.



Footnotes

- ¹ Pall Technical Report FBTPD1006 Rev 2: "Microbial Performance of MEMBRACart XL II 0.45 Micron Final Filter Cartridges"
- ² Pall Technical Report FBTPD1017: "Removal of TAB Spores by MEMBRACart XL II 0.45 Micron Filter Cartridges"
- ³ Pall offers GeneDisc Real-Time PCR system for TAB spore detection and identification. Please request additional information, including Pall Technical Bulletin FBTBGDTABEN "Novel Molecular Assay and Sample Preparation Method for the Detection of *Alicyclobacillus* in Fruit Juice Concentrates and Bottling Process Materials."

About Pall Corporation

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Pall Corporation

Pall Food and Beverage

25 Harbor Park Drive
Port Washington, NY 11050
+1 516 484 3600 telephone
+1 866 905 7255 toll free US


foodandbeverage@pall.com

Visit us on the Web at www.pall.com/foodandbev

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