PALL

Food and Beverage

ENABLING A GREENER FUTURE

Application Bulletin

Protecting your juice processing plant from *Alicyclobacillus* contamination

Overview

In the current competitive environment, safety in the Food and Beverage industry is a question of company credibility and stability.

The emergence of novel spoilage heat-resistant spore-forming microbes such as *Alicyclobacillus* species have further complicated product quality and safety challenges for the fruit juice manufacturers. It has been reported that *Alicyclobacillus* spoilage in the apple juice industry may be responsible for annual economic losses of more than 400,000 US$ in Washington state, USA[1].

Alicyclobacillus species, though non-pathogenic and no-risk for human consumption, do cause important economic damage.

The Challenge

The real challenge coming from *Alicyclobacillus* species is the heat resistance of spores. Typical pasteurization conditions for juice or storage of shelf-stable juice at elevated temperatures may stimulate spore germination, leading to potential juice spoilage. Furthermore, recent studies show the isolation of *A. acidoterrestris* from different samples taken from the juice processing facilities, including water from fruit washing, water from flume transportation, condensate water from the evaporator, and juice concentrate itself[2]. Once introduced into the process by fruit contaminated from the soil, *Alicyclobacillus* may contaminate the entire fruit juice production line. Application of standard pasteurization procedures — even combined with additional disinfection methods — are often not sufficient to provide a spore-free product.

Intensive heat treatment (*e.g.* UHT) would be necessary to kill spores of *Alicyclobacillus* from juice before filling, but this treatment may influence product attributes such as flavor, taste, color, and nutritional value, and may also be cost and energy–intensive.

Due to the serious and increasing threat that *Alicyclobacillus* represents for the juice concentrate industry, the European Fruit Juice Association (AIJN) has written a guideline listing the main critical control points for juice processing[3].

Figure 1 shows the critical control points identified for the apple juice process flow diagram.

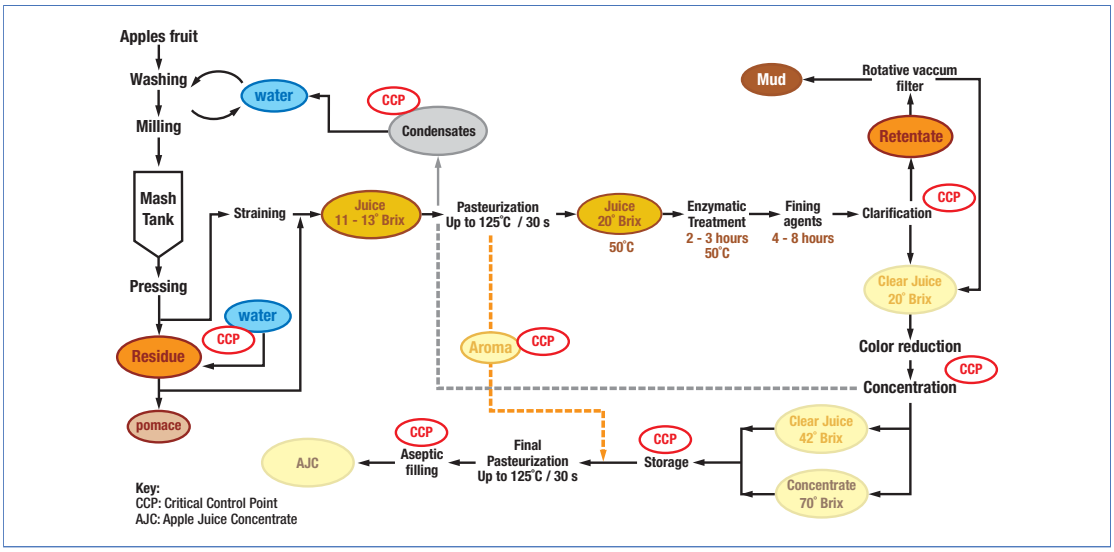

Figure 1 – Critical control points

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Water:
The standard chemical treatment of water may lead to acceptable water quality but it is absolutely critical to select the right oxidizing agent type (peracetic acid, chlorine, hydrogen peroxide, hypochlorite, ozone or chlorine dioxide) and determine the right concentration and contact time. Furthermore, for citrus fruits, chlorine residue can damage the essential oil with chlorinated terpene.

Ultraviolet can also be used, but to ensure the effectiveness of UV treatment, the exposure time and the light density must be constantly monitored, as well as the water turbidity that may offer shade to bacteria.

Fruit Juice:
Ultrafiltration is widely used for juice clarification (*e.g.* apple juice). Theoretically, bacteria cells and spores should not be able to pass through the membrane of the system. However, experience has shown that product after the ultrafiltration stage is not always free from *Alicyclobacillus*[3]. That's why when suitable (*e.g.* fruit juice without pulp), additional barriers are used to achieve juice stability before filling.

Storage tanks:
The intermediate storage of pasteurized juice in tanks or containers is a critical control point as storage temperature may be a catalyst for spores to germinate.

The Solutions

Following AIJN recommendations to cover main important critical control points of the process, Pall has developed specific solutions to remove *Alicyclobacillus* from water and juice.

Water control:
As the trend of todays food industry is to re-use and recycle water as part of its sustainability program, the re-use of condensates for fruit washing and the re-use of water from flume transportation are ways to optimize water usage and save water costs. However, this is possible only if appropriate water treatment is installed to remove *Alicyclobacillus*.

The Pall Aria™ FB membrane filtration system (Figure 2) consists of robust testable hollow fiber modules installed on a stainless steel frame. The system runs in an automatic mode through a simple and easy-to-handle program. The system can be easily installed to treat difficult and critical water such as condensates water or water from flume transportation, ensuring bioburden removal and effective water quality.

Figure 2 – Pall Aria FB systems for water filtration

The use of Oenopure™ or MEMBRAcart XL II filter cartridges (Figure 3) downstream of Pall Aria FB systems ensures the removal of spores from water. Additionally, it enables users to monitor membrane performance by doing integrity testing, as recommended by AIJN.

Fruit juice control:
Flat depth filter sheets are widely used in the apple juice process before final concentration steps, mainly for particle removal, turbidity stability, and *Alicyclobacillus* removal. Even if those filters provide an economical solution with an acceptable level of safety against *Alicyclobacillus*, the

Figure 3 – Oenopure or MEMBRAcart XL II 0.45 µm cartridges for water and juice filtration

stringent requirements of the juice industry are leading to closed systems solutions.

SUPRAdisc™ II modules can provide the required level of removal efficiency while offering no drip losses, reduced handling costs, increased process safety from back pressure shock, and 20 to 50 % reduced filtration costs thanks to longer service life.

Finally, in order to ensure safety against *Alicyclobacillus*, performance monitoring can be done by means of an integrity test. Pall Oenopure II 0.45 µm filter cartridges can be used for the control of spores from fruit juice just before filling.

Storage tank protection:
The use of an inert gas such as nitrogen has been suggested, as well as the use of carbon dioxide on top of concentrate storage tanks. Those gases may be filtered in order to avoid additional contamination from airborne microbes. Emflon® sterilizing grade filters installed as a vent on top of tanks or containers are generally recommended.

The Benefits

Tables I and II show a performance comparison of existing solutions for water and fruit juice treatment.

Table I – Comparison of *Alicyclobacillus* killing or removal from water with different existing solutions

Water treatment/filtration	Log reduction
50 – 200 ppm chlorine for 10 minutes	2 – 3[5]
1000 ppm chlorine or 4 % hydrogen peroxide for 10 minutes	5[5]
40 ppm chlorine dioxide for 30 seconds	4[6]
Oenopure II 0.45 µm filters	> 7.9[4,8]

Table II – Comparison of *Alicyclobacillus* killing or removal from apple juice with different existing solutions

Juice filtration	Log reduction
Flocculation + fining agents	1 – 2[7]
Ultrafiltration (20 – 50 kDa)	2 – 6[7]
Flat depth filter sheets FA050	7.5*
Oenopure II 0.45 µm filters	> 7.9[4,8]

** Internal Pall study*

The Pall Aria FB membrane filtration system can provide:

- Simple single-step water treatment
- Consistent water quality production
- High microbial removal
  - Stainless steel hygienic design and automatic disinfection when the system stays out of operation for more than 24 hours
  - Typically 6 log removal for *Cryptosporidium* oocysts and *Giardia* cysts
- Overall cost improvement
  - Low chemical consumption, low energy consumption and minimal water losses

Flat depth filter sheets FA series can provide:

- Proven retention efficiencies of *Alicyclobacillus acidoterrestris*
- Minimized color adsorption
- Capability of being steam sterilized

SUPRAdisc II modules with K series depth filter sheets can provide:

- Avoidance of contamination risk by a closed filtration system
- Increased process yields due to elimination of drip losses
- Prolonged service life of 20 – 50 % due to backflush capability
- Ease of handling and quick filter change-out
- Resilience to back pressure shocks due to rigidity of the hardware support structure

Oenopure or MEMBRAcart XL II 0.45 µm filters can provide:

- Highest safety level against *Alicyclobacillus acidoterrestris*[8]
- Capability for juice and water applications
- Filter performance monitored by integrity testing
- Low hold-up volume for minimal product losses
- Steamable *in situ*

Emflon sterilizing grade filter options can provide:

- Highest efficiency for airborne spores removal
- Highly hydrophobic membranes
- Filter performance monitored by integrity testing
- Options available that are steamable *in situ*

There are no global water or food regulations. Food contact compliance information for our recommended products may be found at www.pall.com. Please contact Pall to verify that the product conforms to your national and/or regional regulatory requirements.

References:

1. Kang, D.H. (2006). Development of Simple Differenciation Method between Guaiacol Producing and Non-guaiacol *Alicyclobacillus.* Study in progress. Washington State University.
2. Groenewald, W. Gouws, P.A., Witthuhn, R.C. (2009). Isolation, identification and typification of *Alicyclobacillus acidoterrestris* and *Alicyclobacillus acidocaldarius* strains from orchard and fruit processing environment in South Africa. Food Microbiology, 26, 71 – 76.
3. AIJN (2008). *Alicyclobacillus* Best Practice Guideline. European Fruit Juice Association, Brussels.
4. Removal of Thermoacidophilic Bacteria Spores (TAB) by Oenopure II 0.45 µm Filter Cartridges, Technical report FBTPD 1004, www.pall.com.
5. Orr, R. V., Beuchat, L. R. (2000). Efficacy of disinfectants in killing spores of *Alicyclobacillus acidoterrestris* and performance of media supporting colony development by survivors. Journal of Food Protection, 63 (8), 1117 – 1122.
6. Lee, S.Y., Gray, P.M., Dougherty, R.H., Kang, D.H. (2004). The use of chlorine dioxide to control *Alicyclobacillus acidoterrestris* spores I aqueous suspension and on apples. International Journal of Food Microbiology, 92, 121 – 127.
7. Bahçevi, K. S., Gökmen, V., Serpen, A., Acar, J. (2003). The effects of different technologies on *Alicyclobacillus acidoterrestris* during apple juice production. European Food Research Technology, 217, 249 – 252.
8. Rationale for thermoacidophilic bacterial (TAB) spore removal by 0.45 µm membrane cartridge filters. Technical Bulletin FBTBTABEN, www.pall.com.

About Pall Corporation

Pall Corporation is a global filtration, separation and purification leader providing solutions to meet the critical fluid management needs of customers across the broad spectrum of life sciences and industry. We work with our customers to advance health, safety and environmentally responsible technologies. Pall Food and Beverage provides products and services to ensure product quality and maintain process reliability in beverage and food production. Our solutions also assist in consumer protection, the reduction of operating costs and waste minimization.

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Pall Corporation has offices and plants throughout the world. For Pall representatives in your area, please go to www.pall.com/contact

Please contact Pall Corporation for product applicability to specific National legislation and/or Regional Regulatory requirements for water and food contact use.

Because of technological developments related to the products, systems, and/or services described herein, the data and procedures are subject to change without notice. Please consult your Pall representative or visit www.pall.com to verify that this information remains valid.

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