CRITICAL PROCESS FILTRATION, INC.

Removing Heat Resistant Molds and Bacteria During Juice Production

Application Summary

The microorganisms that cause fruit degradation occur naturally and are present in every juice processing operation. Some juice products are pasteurized to kill these organisms and help prevent spoilage. However, the heat used may adversely affect the flavor and overall quality of other juices. Also, not all spoilage organisms are killed by the pasteurization process, so additional methods need to be considered for removing spoilage organisms from juice products.

There are many sources of spoilage microorganisms. The raw juice often carries environmental bacteria, the most common of which are those that cause the fruit to decay in nature. Other bacteria could be carried by sweeteners, flavor enhancers and even by water used as an ingredient or for container washing.

Several papers have been written about steps that may prevent microorganisms from entering the production stream (washing or treating the fruit, etc). There is also some research on alternative processing methods that might kill organisms (High or Ultra-High Pressure Processing, UV light treatment, pulsed electric field, alternative heating methods, even chemical additives). All have their advantages and disadvantages for energy use and product quality. None are designed to physically remove the organisms from the product.

This summary focuses on using filtration to remove organisms, including those that are heat stable and capable of surviving a pasteurization process. For non-pasteurized products, additional filtration steps may be needed due to the higher bacteria load.

Organisms of Concern

Heat-resistant organisms can enter the process system with outside ingredients. Sugar, for example, can be a carrier of the spores of *Bacillus* and other species[4]. Molds and yeasts are found almost everywhere in the environment and can be carried in by ingredients or enter the process somewhere in the plant.

Alicyclobacillus species are the organisms most mentioned as resistant to pasteurization, though other *Bacillus* species may also cause spoilage issues and resist heat inactivation. These "thermo-acidophilic bacteria," or TAB, are the subjects of many articles in the industry press. Two articles describing these heat-resistant organisms can be found in the References at the end of this summary[1,2].

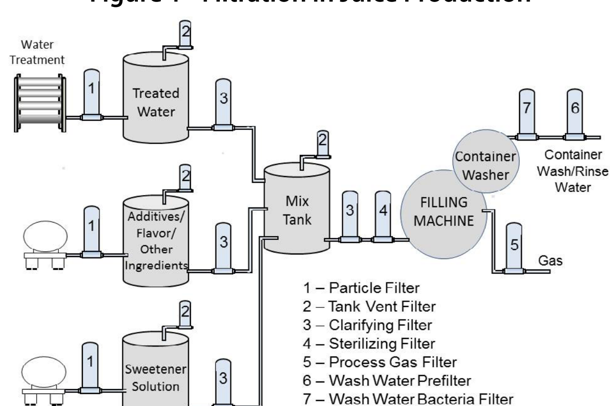
Heat resistant molds, including *Byssochlamys, Paecilomyces, Eupenicillium, Talaromyces* and *Eurotium* have also been found in juices after heat treatment.[2]

Figure 1 shows a simplified fruit juice process with multiple potential sources of organisms and locations for filters to help control or remove them. The Critical Process Filtration filters that can remove these microorganisms are briefly described at the end of this summary.

Choosing the Sterilization Filter

The most critical filter in Figure 1 is the final, "Sterilizing" filter (housing 4) - the one that removes the target organisms. Molds are larger than 1 micron[3] and can be removed by most membrane based filters. A study by Lee, at al determined that either 0.45 micron or 0.22 micron membranes will capture all *Alicyclobacillus* spores[5], which are the form of the bacteria found in acidic fruit juices. Processors may choose the smaller pore size to assure capture of all bacteria, including the vegetative forms of some species, but there is a risk that some flavor or aesthetic elements of the fruit juice will also be captured by membranes with 0.22 micron pores. For that reason, 0.45 micron membranes are used by most juice processors.

Figure 1 - Filtration in Juice Production



Protecting Sterilization Filters

The system shown in Figure 1 has several filters before the sterilizing filter. These filters control the level of organisms from all potential sources as well as extend the life of the sterilizing filter by capturing particles and larger organisms that might prematurely clog that final filter.

The filter housings marked 1 and 2 in Figure 1 hold prefilters that remove larger particles and reduce the amount of organic content in the juice or other ingredients. Housing 1 usually contains depth media based filters to remove sediment and visible particles.

Housing 3 is often a clarifying filter used to remove smaller particles. However, it could be a "bioburden reduction" membrane filter designed to capture most but not all bacteria and reduce the bacterial load that must be removed by the final filter.

The filters are chosen based on the particle and organic content that must be removed. Highly loaded liquids may even use multiple filtration stages for clarifying and bioburden reduction filters. Only a single filter stage is shown here.

Tank Vent and Process Gas Filtration

Tank vent filters (housings marked 2 in Figure 1) are also critical to the quality of the juice. These hydrophobic membrane filters keep airborne bacteria in the environment from entering tanks as they are emptied. The air in juice processing facilities may contain TAB spores, so preventing them from entering the tanks further protects product quality.

Process gas filters (housing marked "5" in Figure 1) are also critical to the quality of the packaged juice. These hydrophobic membrane filters keep particles and bacteria that may be carried by process gas from being deposited in containers as they are filled. Some plants may use process gas as a blanket in storage tanks, also filtered using hydrophobic membrane filters. Almost all process gas filters have 0.22 micron pore size ratings, and most are highly hydrophobic PTFE membrane based.

Safeguarding Filling Operations

Filters shown on the right side of Figure 1 are not used to filter product water. They prevent contamination of the packaging by wash and rinse water during the container washing process (housings 6 and 7) and keep any bacteria that may be carried by process gases (like nitrogen) from being introduced to the final package (housing 5).

Figure 2 – Critical Process Filtration's pleated filters with multiple membrane options are used for spoilage organism removal.

Filter Options

The filters chosen must be designed to function after whatever disinfection or sterilization process will be used. The organisms targeted for removal also need to be considered.

Critical Process Filtration has several filter options, as shown in the table below. These filters are available as cartridge filters and disposable capsule filters as well is in flat disc form for laboratory scale testing.

Contact Critical Process Filtration for help determining the best filter options for you.

Filter Options for Juice Stabilization and Packaging

Process Area	Filter Application	Filtration Function	Critical Process Media*
Prefiltration	Sediment & Particle Reduction	Reduce particle load to protect performance of downstream filters	MB, NS, PD, GD
Bioburden Control and Sterilizing	Bioburden Reduction	Remove most bacteria and molds	BC, CWPS, PS, PVWL
	Bacteria Removal (Sterilizing)	Remove all bacteria and molds	PS
	Tank Vent & Process Gas Filtration	Prevent bacteria from entering tanks when liquid is drawn from them and from entering bottles during filling	TM, PVWB

*Media Codes

GD = Pleated Fiberglass Depth Media
PD = Pleated Polypropylene Depth Media
PVWL = High Capacity Hydrophilic PVDF Membrane
MB = Melt Blown Polypropylene Depth Media
CWPS = High Capacity PES Membrane
PVWB = High Capacity Hydrophobic PVDF Membrane
NS = Nano-Spun Polypropylene Depth Media
PS = Polyethersulfone Membrane
TM – PTFE Membrane

References

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3. Samson, R.A. et al. "Polyphasic Taxonomy of the Heat Resistant Ascomycete Genus Byssochlamys and Its Paecilomyces Anamorphs." Persoonia 22 (2009): 14–27. PMC. Web. 24 Nov. 2014.
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5. Lee, S.-Y., Chang, S.-S., Shin, J.-H. and Kang, D.-H. (2007), Membrane filtration method for enumeration and isolation of Alicyclobacillus spp. from apple juice. Letters in Applied Microbiology, 45: 540–546. doi: 10.1111/j.1472-765X.2007.02229.x

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