



Application Bulletin

Simple, Safe, Single-pass Filtration for the Flavor Industry with Pall 'SUPRA' Technology

Overview

A wide array of flavors and flavor blends are used in food and beverage production. These consist of thousands of different flavor-contributing natural and synthetic compounds, including essential oils, aroma chemicals, flavor extracts, distillates, oleoresins, reaction flavors, and others. These are sensitive and highly fragile chemical compounds which must be protected from oxidation and other damaging effects of processing.

Flavors also include additives such as flavor enhancers, sweeteners, spices, fruit preparations, preservatives, binders and solvents to achieve the desirable properties and flavor profiles for end-use. Figure 1 illustrates a simple concept of flavor blend production.

The nature of the flavoring compounds depends on their source and how they are produced. Whether extracted by multiple methods from natural materials, or created through chemical reactions,

the resulting compounds may be impacted by any of the four compounds listed below:

1. Suspended particulates
2. Colloidal haze
3. Microorganisms
4. Varying amounts of impurities

Suspended Particulates

Coarse to fine particulates originate primarily from the following five items listed below:

1. Plant raw materials and flavor additives
2. Processing aids such as filter aids
3. Activated carbon or ion exchange resins
4. Particles formed due to processing techniques such as chill precipitation
5. Impurities from processing equipment

Colloidal Haze

Colloidal haze is caused by the presence of waxes, oil/water traces, lipids, polysaccharides, and fatty

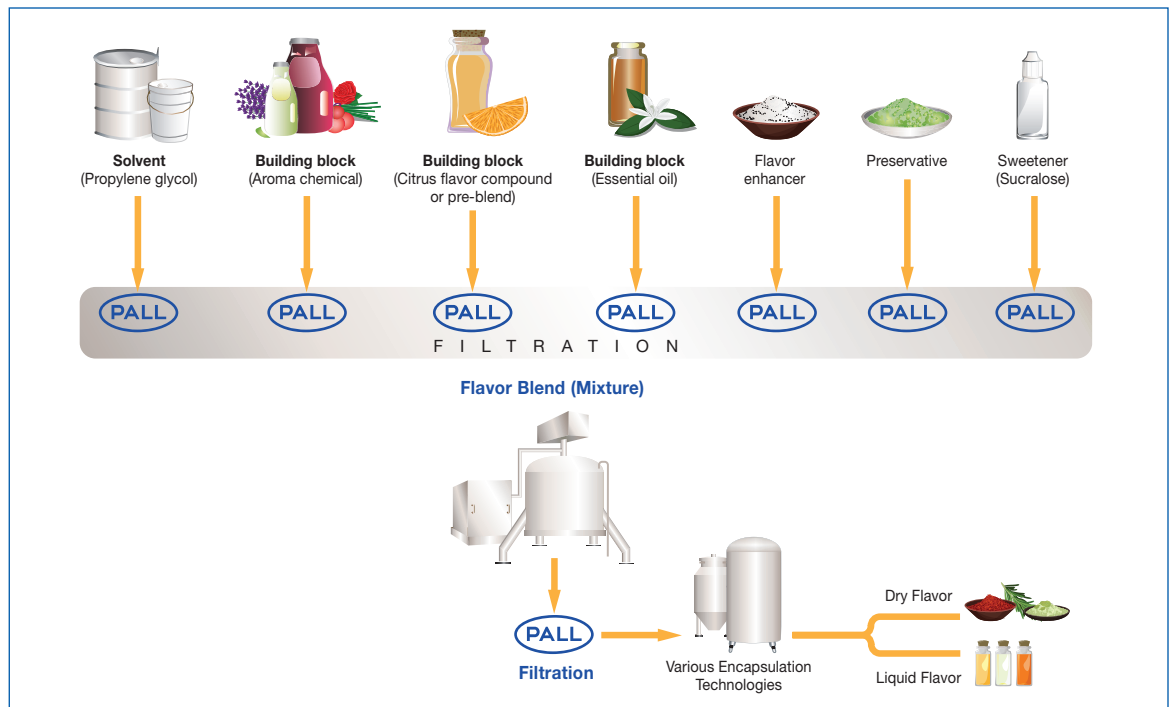


Figure 1: Conceptual diagram of flavor blend production. A flavor blend can consist of over 100 chemical compounds, including flavor building blocks which contribute flavor and flavor additives. The flavor blend and/or the individual components may require filtration.



acid esters. The solubilities of which, are impacted by the types of carrier solvents used and by the processing temperature. **Colloids can be challenging to remove.**

Microorganisms

As a result of dealing with natural raw materials, the flavor compounds might be contaminated with microorganisms (e.g. yeast, molds and bacteria, including thermoacidophilic bacteria (TAB) spores).

These contaminants, if not eliminated, give rise to final product turbidity of both particulate and colloidal origin, separation of oil and water phases, precipitation after packaging and microbiological instability.

How to Address Removal of These Compounds?

Clarifying and polishing filtration is key to achieving the desired visual clarity and microbiological quality of flavor ingredients, flavor additives and final flavor blends. The most sustainable filtration solutions in flavor manufacturing are ones which:

- Respect the flexibility required to process very diverse products in small to large batch sizes
- Satisfy the production goals of minimum product losses, process safety, efficiency, cost-effectiveness and minimum downtime

The Challenge

A manufacturer of natural flavors was using sparkler filtration and some paper filtration to process upwards of 25 different proprietary flavor blends from purchased ingredients and flavor washes from citrus oils. To clarify the flavors, three sparkler filters on mobile carts were in use, using a combination of filter sheets and different filter aids, including diatomaceous earth and magnesium carbonate ($MgCO_3$). Filtration was slow and quality was inconsistent. Many batches often needed to be processed in multiple passes through the sparkler filters.

Batch sizes ranged from 100 to 30,000 liters (26 to 8000 US gallons), all processed through the same equipment. Product change-overs meant the sparkler filters had to be disassembled, cleaned and reassembled each time, otherwise the result would be flavor carryover among different products. Smaller batches meant that the sparkler filters were torn down and cleaned more frequently. Premature plugging of the filters also necessitated filter change-out.

In more extensive batch process runs, lasting several hours, the filters were cleaned at minimum every 3-4 hours due to rigorous corporate sanitization requirements. Filter disassembly, cleaning and reassembly took ½ - 1 hour. This

process was time-consuming, labor-intensive and costly. Due to the high degree of manual handling involved, personnel exposure to filter aids and solvents was problematic.

The hold-up volume of the sparkler filters resulted in high product losses, especially on small batches, making small-batch filtration economically unsustainable. Remaining unfiltered product was processed through cone filters, which utilized paper as the filtering medium, a rudimentary solution for achieving visual clarity. The cone filtration step also exposed the product to the environment and personnel, causing unnecessary oxidation and potential safety issues due to the presence of solvents in some of the fluids.

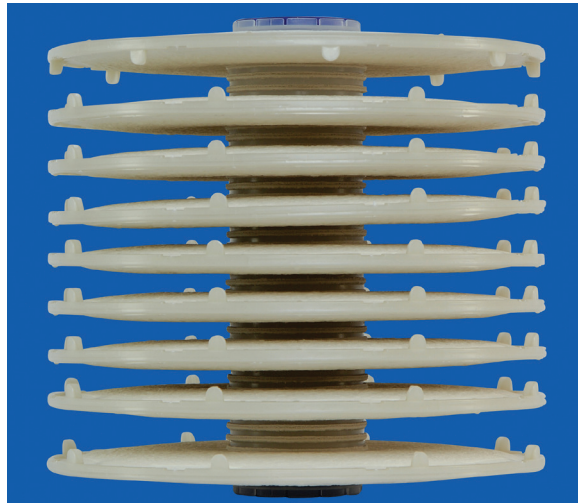
By implementing a new filtration solution, the manufacturer wanted to reduce the batch rework needed to satisfy quality requirements and reduce the process downtime, labor and cost associated with the frequent need to disassemble and clean the existing filters; all while maintaining or improving filtrate quality.

The Solution

Pall 'SUPRA' filtration technologies were selected as efficient and innovative solutions to address the diverse requirements of the many flavor products at this facility. Pall's SUPRAPak™ products (Figure 2) were the primary choice for most of the applications, overcoming all the disadvantages of the conventional sparkler filtration method. In a few cases, filter aids were still required due to the nature of the impurities in the flavors. However, in these specific cases, the filter aids were used in combination with Pall's SUPRADisc™ I lenticular modules (Figure 3) that have increased space in between cells to enable cake formation.



Figure 2: Each SUPRAPak module is a dense package of filter sheet material, providing exceptional throughput and excellent filtrate quality.



SUPRADisc I module with cake space for cake filtration

Figure 3: SUPRADisc I lenticular modules are uniquely designed for cake filtration with filter aids.

The most obvious and immediate improvement that the customer witnessed was the ability to achieve extremely quick, one step, single-pass filtration for the majority of the products, replacing the sparkler filters and eliminating the need for most filter aids. Results such as these changed the standard:

- QA and customer approval of filtrate quality increased by 30%.
- Process time reduced by 87% on average.
- Productivity increased by 700%.

SUPRApak Optimizes the Benefits of Sheet Filtration

Filter sheets are uniquely suited to removing not only particles but also the colloidal hazes present in flavor ingredients and blends. They are also capable of achieving sound microbial bioburden reduction, although critical microbial removal is only satisfied by final membrane filters.

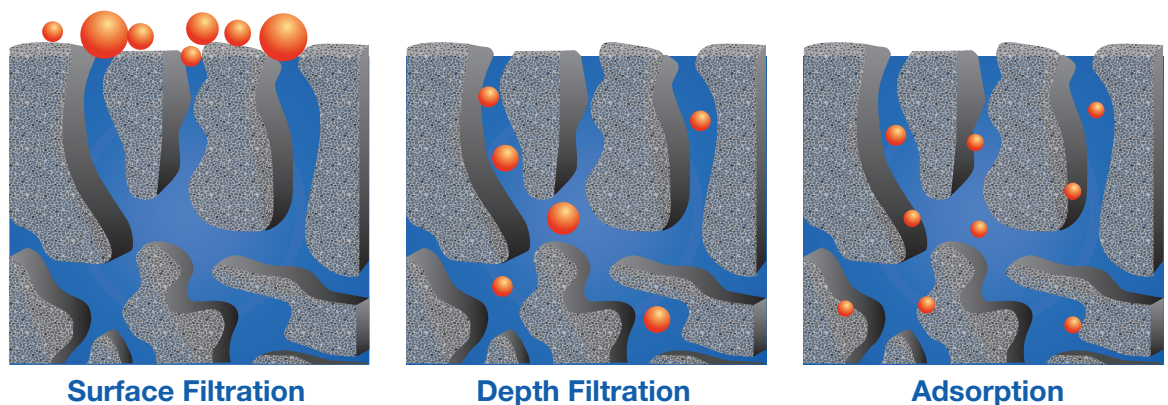
High Adsorptive Effects

Three filtration mechanisms occur in filter sheets: surface, depth and adsorptive filtration (Figure 4).

Traditional filtration products such as paper, bag, and depth filter cartridges primarily achieve surface filtration and some depth filtration depending on filter media thickness. However, adsorptive filtration, is vital for removing colloids, and is only possible within a filter sheet matrix. Classic filter sheet media consists of a mixture of cellulose fibers, diatomaceous earth, perlites and resin binders, which enables efficient adsorption of contaminants.

SUPRApak filters are filter sheets configured in a unique high-area pack design, which offers the benefits of sheet filtration without the disadvantages of classical flat sheet filtration. Due to the unique flow path of the filtered fluids through the SUPRApak filter pack, called 'edge flow'¹, there is greater contact time of the fluids with the filter media, resulting in excellent adsorption effects. The result of this flow configuration is not only exceptional filtrate quality but much higher flow capacity and throughput than alternatives, including flat sheets and lenticular modules.

SUPRApak modules are available in 12 different grades, providing coarse to very tight filtration. SUPRApak SW7700 grade was selected to



Surface Filtration

Depth Filtration

Adsorption

Figure 4: The combined mechanisms of surface, depth and adsorptive filtration achieved by filter sheets successfully removes particles and colloids. SUPRApak technology capitalizes on these benefits but avoids the disadvantages of classical sheet filtration.



replace paper filtration, and SUPRApak SW5500 grade to replace sparkler filters utilizing flat filter sheets with diatomaceous earth dosing. In most cases, filter aids were eliminated, a key sustainability improvement. The elimination of filter aids means less personnel exposure, less downtime for cleaning, less waste, and less need for downstream polishing filtration.

Flexible, Modular and Simple Installations

SUPRApak modules and installations are available in different diameters and stack heights. This flexibility and modularity of design is ideally suited to handle a wide range of batch sizes, by matching batch sizes to module sizes and limiting waste of unused filter capacity. Figure 5 illustrates module choices, and Figure 6 shows the modular concept.

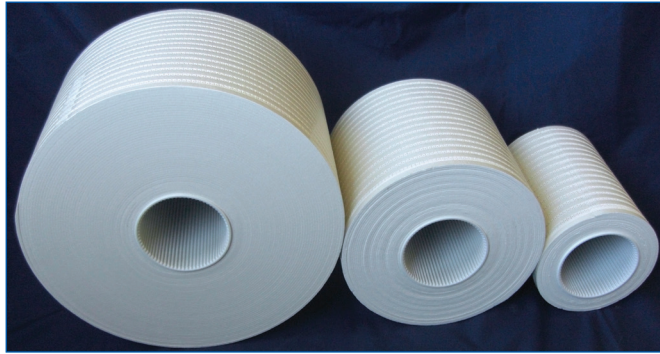


Figure 5: SUPRApak modules are available in three sizes of varying diameters allowing flexibility in batch processing: **SUPRApak S** (183 mm/7.2 in); **SUPRApak M** (285 mm/11.2 in); and **SUPRApak L** (415 mm/16.3 in)

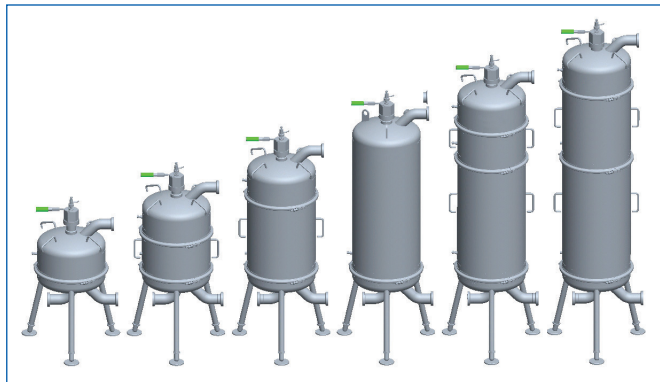


Figure 6: Modularity of housing design allows flexibility in production. The housings feature split dome design, which enables the use of the same housing for different module stack heights.

The unit is simple to assemble and disassemble. The entire process takes about 3 minutes. Figure 7 highlights a self-contained mobile SUPRApak rig complete with feed pump, controls, piping and basic monitoring devices (pressure gauges, flowmeter) to simplify filtration set-up at the positions where they are needed.

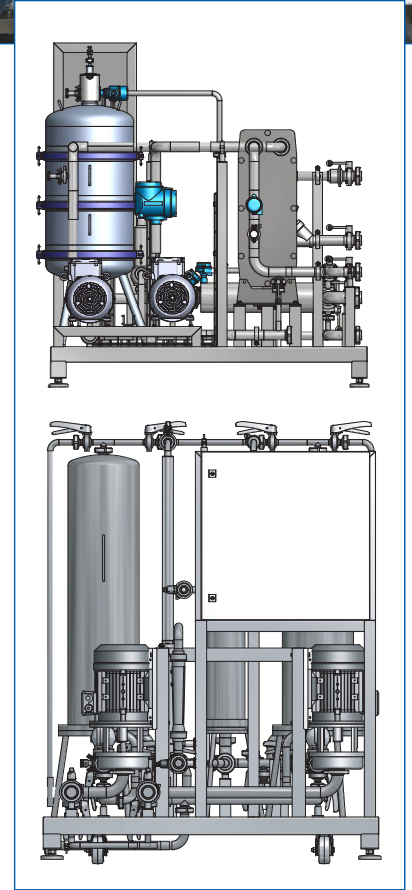
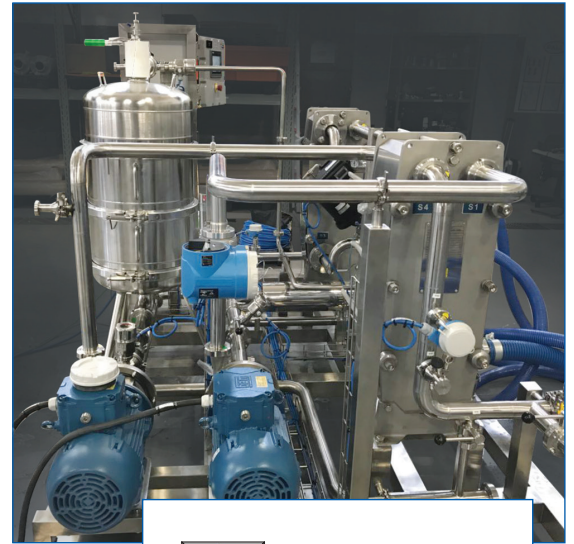


Figure 7: Self-contained 'SUPRA' rigs simplify installation and assist ease of use.

Safe, Closed System Enabling High Product Yield

The SUPRApak system is a fully enclosed installation (Figure 8), with low product hold-up volume. At the end of filtration, the housing can be pressurized with gas to empty the content and therefore limit product losses. This is an important feature, especially for high-value flavors.



Products may be sensitive to oxidation, corrosive for the skin (e.g., some citrus oils), and many are solubilized in flammable solvents; therefore vapor release to the environment must be prevented. The enclosed housings enable product, personnel and environmental protection. For solvent-based fluids, housings are available in an explosion-proof version.

Other 'SUPRA' Uses in Flavor Applications

To separate traces of water from essential oils, typically originating from the raw plant materials or the extraction process (e.g., steam distillation), SUPRApak PZ modules, consisting of 100% cellulose media are used. The cellulose fibers absorb the water while the oil passes through.

Separating waxes from citrus oils is another application that can be served by a SUPRApak solution, depending on the amount of waxes present².

To separate traces of citrus oils from citrus flavor washes, Pall offers a lenticular solution with SUPRAdisc I that is uniquely designed for precoat and cake filtration with filter aids (Figure 3).



Figure 8: Cutaway view of SUPRApak housing and modules shows enclosed design.

The Benefits

The flavor manufacturer highlighted in this article realized game-changing improvements to their filtration process, which translated to substantial cost savings of over \$1 million in three months at one manufacturing site. In all respects, SUPRApak technology presented a superior alternative to sparkler filters.

The manufacturer gained the following benefits:

- Excellent filtrate quality, meeting quality requirements with single-pass filtration. QA and customer approval of filtrate quality increased by 30%
- Reduced process time, by 87% on average, resulting in a 700% productivity increase
- Reduced labor and process downtime, due to low frequency and ease of SUPRApak module change-out and cleaning
- Flexibility to handle diverse, proprietary product types and a range of batch sizes, due to a variety of SUPRApak filtration grades and types, module sizes, and modularity of SUPRApak equipment design
- High product yield, due to the ability to empty SUPRApak housings by inert gas pressurization
- Improved product, personnel and/or environmental protection due to enclosed system
- Sustainability improvement, reduced waste and less personnel exposure to filter aids, due to almost complete elimination of their use



Pall SUPRA Technologies Satisfy These Targets in the Flavor Industry

- ✓ Exceptional product quality
- ✓ Single-pass filtration
- ✓ Increased process efficiency
- ✓ High product yield
- ✓ Reduced process downtime
- ✓ Improved sustainability
- ✓ Flexible, modular installation
- ✓ Simple operation
- ✓ Enclosed system for process safety
- ✓ Cost-effective solution

References

- ¹ Please request Pall brochure FBSUPRAPAKEN, “SUPRApak Depth Filter Modules – Depth Filtration Goes Edge Flow”
- ² Please request Pall Application Bulletin FBABSUPRAFLVREN, “Increase Filtration Capacity and Reduce Process Time in Citrus Oil De-waxing Applications”

About Pall Corporation

Pall Corporation works to protect what matters everyday by providing filtration, separation, and purification solutions to businesses across the globe. Pall serves the food and beverage industries with advanced membrane filtration technology and systems, enabling companies to produce shelf-stable, consumer-safe products at the lowest operating cost.

There are only a few companies in the world that can effectively do what we do, and none of them match our combination of product breadth and performance across traditional filters and system solutions with our depth of application knowledge.

To learn more about Pall Food & Beverage visit www.pall.com/foodandbev.



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