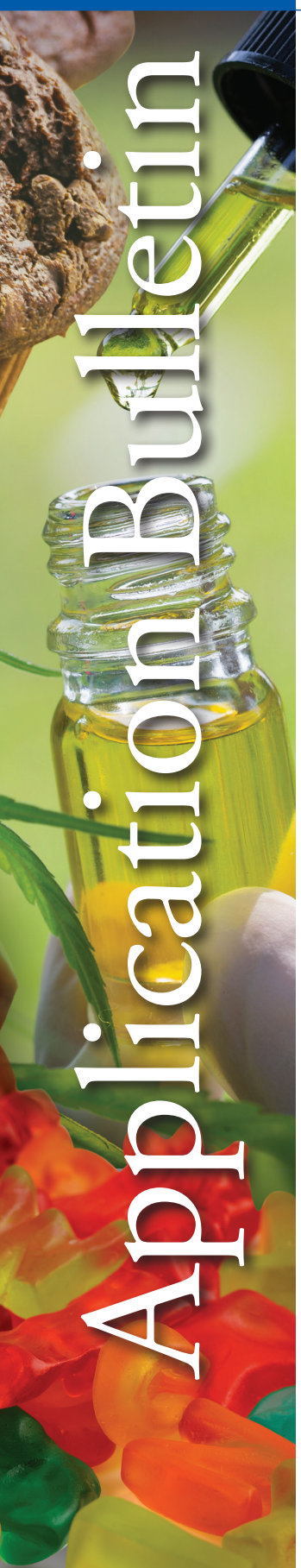
Food and Beverage



Pall "SUPRA" Technologies are Key to Filtration for CO_2 Extraction Method in Cannabis Oil

Overview

Today the global cannabis oil market is growing at a rapid pace. Experts predict the market for cannabis oils to grow at a rate of 31.90% from 2020 to 2027 with the combined market value reaching $45 billion by 2024[1].

To produce cannabis oil, the compounds of interest must first be extracted from the plant. There are several ways to extract the oils, however, CO_2 extraction is one of the most common methods. In CO_2 extraction, "supercritical" CO_2 acts like a solvent to flush out the active ingredients from the plant matter. Cannabis oil producers then apply expert and proprietary techniques for their unique brands. Clarification and particulate removal are common, but an essential step to provide consumers with a high-quality end product.

Buchner funnels, as well as sheet filter presses have commonly been utilized for filtration to produce cannabis oils. At small scale these methods offer producers the ability to process small batches of cannabis oil. However, both Buchner funnels and filter presses pose several challenges. These include long periods of time to process, labor intensive to change-out filters, lower yields due to drip losses, high difficulty of use and open-air systems that can lead to quality and safety concerns. To help solve these production concerns, Pall has leveraged its experience and filtration technologies used in other industries.

The Challenge

As cannabis oil has become legalized in different parts of the US and all of Canada, the demand for cannabis oil has rapidly increased. This increase in demand has necessitated a simultaneous increase in volume from companies that are producing cannabis extracts.

Specifically for supercritical CO_2 extraction, producers have experienced significant challenges downstream in the process. After extraction, the oil undergoes a "winterization" process where the oil is chilled to -40 °C / -40 °F to further purify and refine the extract to increase its quality and value. At this cold temperature, the plant waxes precipitate and are more easily removed with filtration.

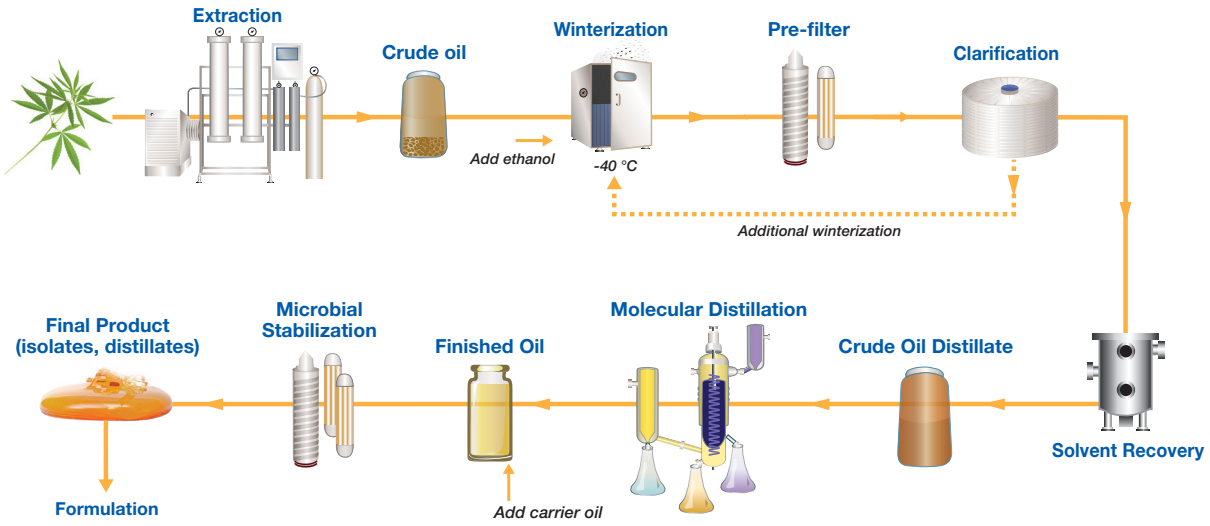


Figure 1: Typical Workflow for Supercritical CO_2 Extraction

*Filtration. Separation. Solution.*SM

The method of filtration post-winterization varies based on the size of the batches. Cannabis oil producers' production levels range from several liters a day to several hundred or even thousands of liters a day. Extractors commonly run into issues with product loss from filter changes, extremely long times to filter out waxes/lipids, breaking of beakers from out of line filtration systems, and unpredictable product availability from suppliers.

The Solution

To meet the economic, quality and clarity requirements, Pall worked with cannabis extract producers using CO_2 based systems to find a simple yet flexible solution.

For extract clarification, filter sheet-based products enable a high product quality. The sheet media has a unique matrix of components that remove unwanted waxes while maintaining the quality-enhancing components that result in a clear, bright product. Filter sheets provide an excellent combination of adsorption and mechanical removal making them the ideal solution. However, the typical flat sheet and lenticular module formats have drawbacks. Pall's new SUPRA technologies are the latest development in sheet filtration that alleviate the pain points associated with using filter presses.

SUPRApak™ Modules

SUPRApak modules combine the benefits of sheet filtration with a new design and flow configuration that fits into an enclosed solution. Sheet media is wrapped around a central permeable core with external straps that attach the sheet material to the core. The sheet material is punched with an intricate pattern of feed and filtrate channels which direct fluid flow through the module. The unfiltered fluid enters the module from the outside through feed channels. The differential pressure pushes the fluid flow through the sheet media in a direction toward the filtrate channels. The filtrate channels then carry the fluid toward the center core where it exits the modules. See Figure 3.

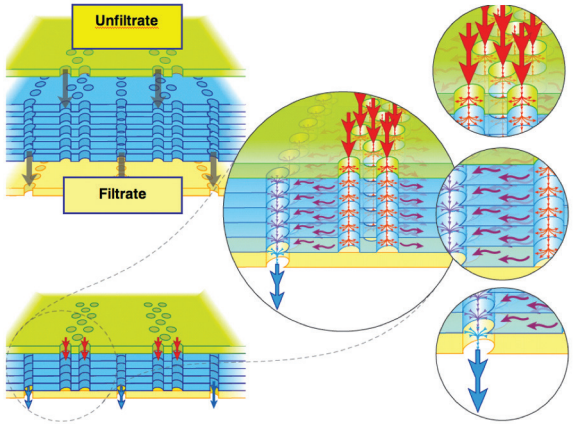


Figure 3: SUPRApak Module Flow Configuration

The high packing density of SUPRApak modules make them economical and a good fit for cannabis extract applications. SUPRApak M 12 inch modules have about 1.7 times the filter area of typical 12 inch lenticular modules and would replace about twenty 40 x 40 flat sheet filters. Additionally, for smaller batches, SUPRApakS size 7.5 inch modules can be used. Also, the unique flow configuration maximizes the adsorption capability of the sheets enhancing removal of waxes and other particles that cause turbidity.

Main SUPRApak Benefits for Cannabis Oil Producers

- ✔ Unique flow configuration that maximizes filtration and adsorption
- ✔ Compact configuration to maximize recovery of valuable oil
- ✔ Higher filter area than most lenticular modules to accomodate for further growth

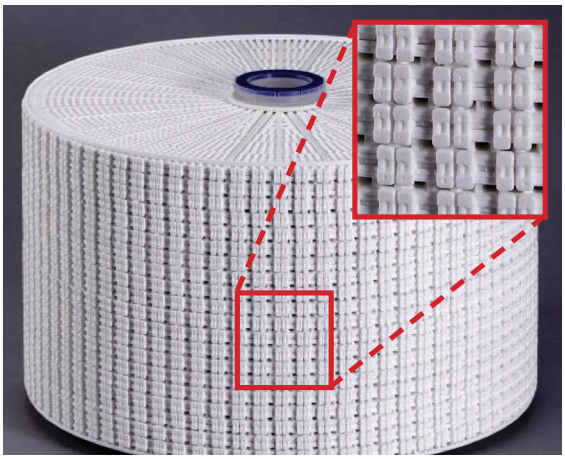
Figure 2: SUPRApak Module and Enclosed Housing Assembly

SUPRAdisc II™ Modules

SUPRADisc II Modules, similar to SUPRApak Modules, are sheet-based product based on a combination of surface, depth, and adsorptive filtration. Selected combinations of cellulose, different types of filter aids, or other ingredients in the filter matrix result in a highly porous structure, which achieves effective filtration, including coarse to fine particle removal, colloidal removal, and final filtration.

Classic stacked disc modules represent first generation module design, but they have performance disadvantages, such as open media resulting in tearing and difficulty handling and inability to withstand reverse pressure. With the robust separator design, SUPRAdisc II offer increased capacity, reliability, handling advantages, and robustness, which satisfies customer needs and requirements for higher performing products.

SUPRAdisc Modules comes in two sizes, 12” and 16” modules boasting surface areas of 1.8 m^2 and 5 m^2 respectively. Customers can easily scale their operation up to 4 modules that can be vertically stacked.



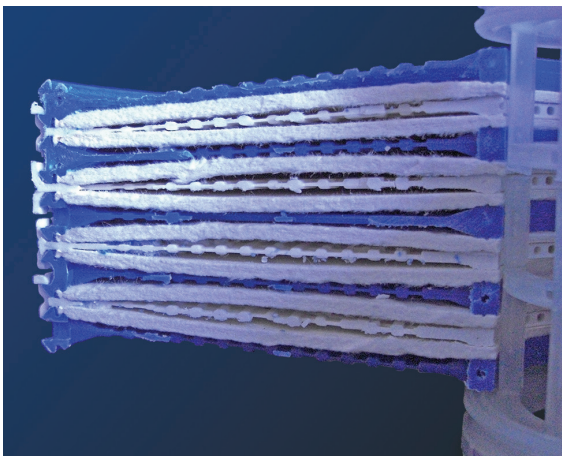


Figure 4 and 5: SUPRAdisc II 16” module, SUPRAdisc II patented separator technology

Figure 6: SUPRAdisc modules and housings

Main **SUPRAdisc II** Benefits for Cannabis Oil Producers

- ✔ Modular, such that several grades of media are offered, enabling easy optimization for your specific fluid
- ✔ Shortened active filtration time to filter waxes and unwanted lipids

Technical Considerations for Deciding Between SUPRAdisc II and SUPRApak Modules

SUPRAdisc II Modules	SUPRApak Modules
Moderate to large batch size (26 to 132 gallons)	Large volume of extracts
High solids load / high volume of waxes	Low solids load / minimal wax
Cold-pressed extracts	SUPRApak S for small batch size (13 gallons or less)
No pre-filtration used	Higher filter area compared to lenticulars

In addition to the benefits described above when compared to flat sheets, SUPRA products have also demonstrated advantages over Buchner funnels. Cannabis oil producers have seen significant improvement in the time it takes to filter product utilizing either the SUPRApak or SUPRAdisc II Modules.

For example, at one site, a customer trialed both industrial scale Buchner funnels and Pall's SUPRApak technology. The filtration time with SUPRApak modules was shorter, reducing time from **5 hours to 13 minutes for 62 gallons (235 liters) of product. SUPRApak technology reduced filtration time by 96%.**

SUPRAdisc II modules provided similar benefits at one customer that had previously utilized Buchner funnel and filter sheet technology to filter cannabis oil. The customer had a significant bottleneck during the clarification stage. Pall was able to utilize **SUPRAdisc II Modules to filter 82 gallons (310 liters) in only 25 minutes.**

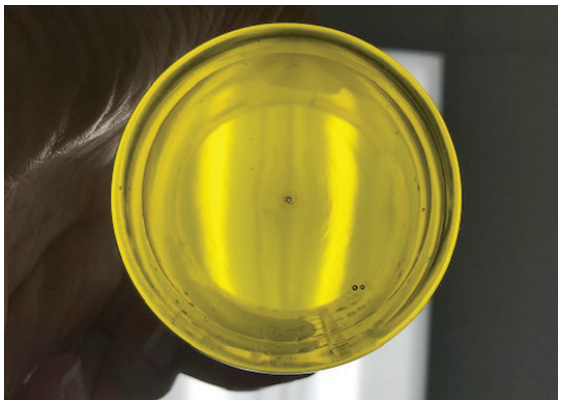
SUPRA Module Housings

SUPRApak and SUPRAdisc II Modules can be fitted into enclosed housings that maximize product protection, minimize product losses, and eliminate oxidation of products. Pall offers a range of stainless-steel module housings depending on specific customer requirements. The closed assemblies eliminate drip losses resulting in higher yields than traditional sheet filter assemblies. Furthermore, when a batch is complete, gas can be used to push out the remaining liquid in the housing resulting in more recovered product and faster filter changes.

The Benefits

With Pall's enclosed filter solutions, cannabis extract manufacturers can now have cost effective and quality filtration to meet their specific operating requirements. By implementing, modular technology, manufacturers can realize the following benefits:

- Improved filtrate quality utilizing high quality products that are reliable and durable
- GMP and FCC compliance for applications in cannabis oil
- Simple inline solution, which reduces oxidation
- Enclosed assembly increases process security by preventing contamination that can result from open filter sheet or Buchner funnel assemblies
- Enclosed assembly increases yield by eliminating drip losses and enabling a gas blow down at the end of a batch
- Module change-outs are quicker and easier than traditional sheet filter changes
- Reduced operating costs with a short return on investment
- Minimal spare parts and maintenance



Figures 7 and 8: Cannabis oil samples from a CO_2 extraction process. Raw oil *(left)*, after filtration with SUPRA technology for clarification *(right)*.

Pall Food and Beverage Cannabis Filtration Expertise

Extracting the various cannabinoids is a complex process that is continually evolving. With over 70 years of application experience and product development in Food and Beverage, Pall offers itself not only as an informed filtration solutions provider, but also as an informed technical partner who understands how to adapt and create products that meet the needs of emerging markets. As production needs evolve within the cannabis market, Pall is the partner that can adapt and grow in this rapidly changing market.

References

[1] Data Bridge Market Research—
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About Pall Corporation

Pall Corporation works to protect what matters every day 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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