FOOD & BEVERAGE

Technical Report

Optimize the Cannabis Filtration Process with Pall SUPRApak™ Technology

Introduction

In recent years, cannabis has globally surged in popularity, and not just within the United States. The global legal cannabis market was valued at USD $17.7 billion in 2019 and is expected to expand 18.1% (CAGR) through 2027[1].

With the market set for rapid growth, cannabis oil producers look to satisfy demand as quickly and safely as possible. For more than three years, Pall Corporation has been working closely with cannabis oil producers to better understand their pain points and needs. In particular, the ability to clarify and polish ethanol derived extracts before solvent recovery has been identified as an industry pain point. Lack of an efficient clarification step will lead to downstream bottlenecks during the solvent recovery and molecular distillation steps, where constant cleaning of distillation systems will be required. It should also be noted that lack of efficient clarification can yield lower than expected potency levels.

Figure 1: Display of results from trial conducted at Helderpad. The container on the right and left show cannabis oil before and after use of SUPRA products.

To assist with clarification and polishing, Pall SUPRA technologies can easily integrate into most workflows yielding a bright, particulate-free product. Pall Corporation's SUPRA products consist of our SUPRAdisc™ II lenticular format filter as well as our next generation SUPRApak modules. Both SUPRAdisc and SUPRApak modules consist of sheet media where filter aids are impregnated into a cellulose matrix. Our SUPRA technologies come in several grades consisting of different ratios of filter aid, resulting in varying removal efficiencies. *(See Table 1 for more information on Pall filter grades).* Customers often require a laboratory scale proof of concept which can be easily accomplished and scaled by leveraging Pall Velapad filter housing that can be equipped with similar filter media used in the larger SUPRAdisc and SUPRApak modules.

A common question Pall receives is "What is the anticipated throughput we can achieve with this filter"? There are several variables that impact total throughput, therefore making it challenging to objectively answer this question. In partnership with Helderpad, Pall Corporation worked to provide a generic answer to this question, thus enabling customers to assess their current process relative to the outlined parameters and better understand anticipated outputs.

Extraction Method

Based in Washington State, Helderpad is an international collection of botanical processing specialists, with decades of experience, committed to continuous research, development, and diffusion of innovative botanical processing technologies. Helderpad designs ethanol extraction, solvent recovery, and short path distillation systems for complete and continuous biomass to distillate processing.

Helderpad has developed the continuous screw extractor (CSE) 100, capable of processing 57 KG (125 lbs.) of milled biomass in an hour. This extractor uses cryogenic ethanol at -40° C (F) to "shower" the milled biomass. The biomass is in continual movement by using a screw in the center of the vessel. As a result of the constant motion, there are large quantities of fine plant material, making proper filtration an integral step to avoid developing downstream problems and maintaining high potency values.

[1] https://www.grandviewresearch.com/industry-analysis/legal-marijuana-market

Table 1: Breakdown of SUPRAdisc II and SUPRApak Grades

Sheet Media Type	Application	Examples of Use
EKS, EK1, EK KS 50, KS 80	Fine Filtration	Microorganism reduction and yeast removal in wine Microorganism reduction in beer with moderate to high microbial load Final filtration of juice and juice concentrate prior to bottling Microorgaism reduction in sugar syrups Microorganism reduction in enzyme solutions
K100, K150, K200, K250, K300	Polishing Filtration	Polishing filtration of wine Microorganism reduction in beer with low microbial load Fine filtration of beer and yeast removal Fine filtration of beer following DE prefiltration Polishing filtration of beer Prefiltration of juice prior to final membrane filtration Haze removal in apple juice before bottling Polishing filtration of sugar syrups Polishing filtration of enzyme solutions Polishing filtration of thick liquor gelatine Secondary sedimentation prevention in tea
K700, K800, K900	Coarse Filtration	Clarification of wine Particle removal in fruit juice Particle removal in tea-based beverages Prefiltration of juice concentrate Polishing filtration of olive oil Clarification of enzyme solutions Clarification of thin liquor gelatine

SW Range	Examples of Use
SW 5200	Final filtration of enzyme solutions Final filtration of sugar solutions
SW 5300	Final filtration of fructooligosaccharides Fine filtration of beer
SW 5500	Final filtration of sugar solutions Fine filtration of beer
SW 5600	Final filtration of sugar solutions Fine filtration of beer
SW 5700	Clarifying filtration of beer Final filtration of sugar solutions
SW 5800	Filtration of enzyme solutions Clarifying filtration of beer
SW 5900	Polishing filtration of thin liquor gelatine Polishing filtration of flavors Clarifying filtration of beer
SW 7000	Clarifying filtration of thin liquor gelatine
SW 7100	Clarifying filtration of thin liquor gelatine Clarifying filtration of flavors
SW 7300	Coarse particle removal

The now cannabinoid laden ethanol is recirculated through a 10 µm bag filter to remove the plant particles and then further used in subsequent extractions as new biomass is continually added to the extractor. After 10 minutes of continuous movement, the biomass reaches the screw press, which ensures there is no extract left in the saturated biomass. The ethanol that comes out of the screw press also passes through the 10 µm bag. Once the recirculated ethanol's absorption capacity is reached, the fluid stream is redirected to a buffer tank that then passes through a 25 µm metal filter to mitigate plant particles. Once the cannabinoid rich extract passes through the coarse metal filter, the product can be rechilled or move directly to clarification.

Procedure

The goal of this study is to gain a better understanding of the anticipated throughput of Pall filter sheets by leveraging real-world cannabis extract samples filtered through Pall Corporation's lab scale setup.

What is flux?

Flux is flowrate through a defined effective filtration area and reported in LMH (Liters/hr)/m^2). The value is used to emulate flowrates utilized at production scale. Moreover, during the test trials, Helderpad leveraged Pall Corporation's Velapad housing fitted with depth filter sheets, allowing for a filter cake to form. The flowrate was constant at 20-22 mL/min resulting in a calculated flux of approximately 570 LMH. Contrary to what many believe flowrate does impact filtration efficiency. However, when working with amorphous solids, such as waxes and lipids, contact time with the filter defines filtration efficiency. If the flow is too fast it is likely that particulate elute will be observed through the filter media in downstream samples. This is one of the reasons that filtration processes must be properly sized balancing flowrate and surface area to meet the customer specific needs. During the trial, Helderpad trialed two grades of filter sheets, specifically Pall's K700 and K100 series.

During the filtration process, the temperature ranged from 0 °C (32 °F) to -10 °C (14 °F). This fluctuation of temperature resulted in a wax content of 0.1 – 0.5%. The total solid load of the filtered material was 5% (feed used for K100) - 10% (feed

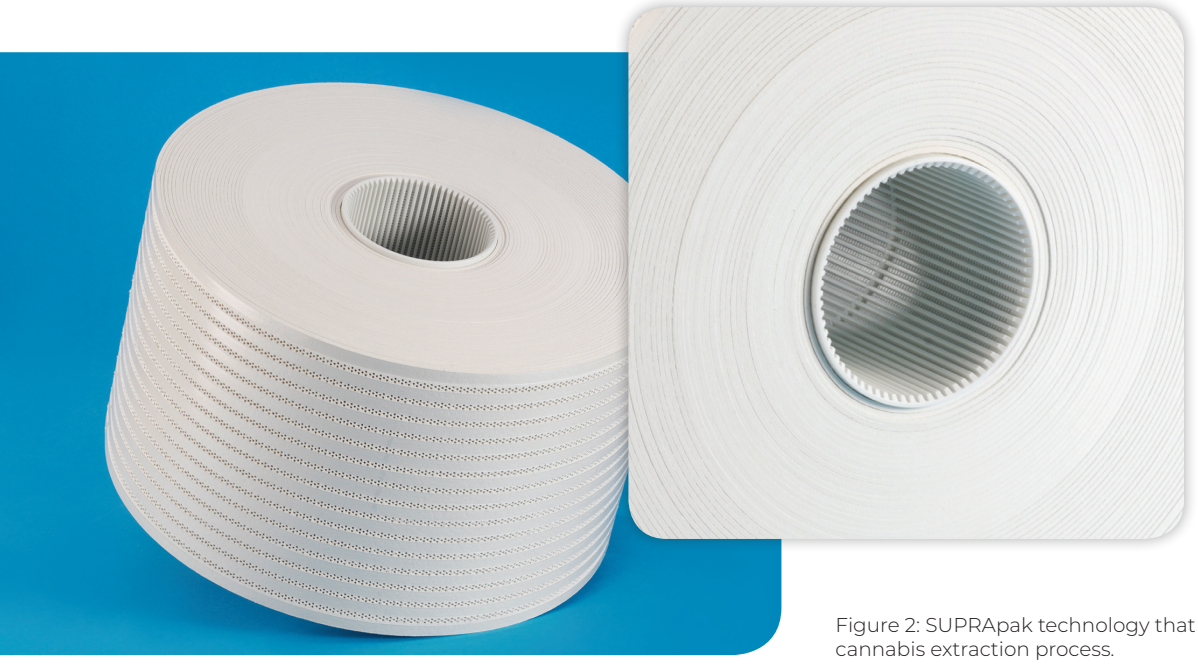

Figure 2: SUPRApak technology that is utilized in wax removal during cannabis extraction process.

used for K700) which was predominantly plant-based. Turbidity measurements were taken throughout the filtration run to better understand particulate removal.

For the purpose of the study, Helderpad and Pall determined that the cutoff point for each grade would be either an observed differential pressure of 35 PSI, an observed flowrate less than 5 mL per minute, or 6.5 L of filtered product.

Data and Discussion

Pall suggests monitoring both flowrate and differential pressure during filtration. These two parameters help evaluate filter service life. Pall SUPRA products are integral up to 2.5 bar (35 PSI) and many customers have a flowrate cutoff to initiate a filter change. In both cases, the Velapad fitted with K700 and K100 depth filter sheet media grades maintained a constant flow throughout the filtration of the 6.5 Liters where neither reached the terminal pressure of 2.5 bar (35 PSI). In both cases a turbidity reduction was observed. Turbidity, often reported in NTU (nephelometric turbidity unit), is used to gauge the suspended solids in a sample where the higher the value, the more suspended solids are present. In many other industries NTU is used as a quality specification in the manufacturing process.

Pall Corporation currently offers SUPRA sheet-based modules that come in several sizes; 0.4 m^2, 1.8 m^2, 5 m^2 and 8m^2 providing production flexibility. Based on laboratory testing of a single lot an estimated throughput can be calculated using a scale factor of 450/m^2. This information should not be used as an objective answer to anticipate throughput but rather a guide for comparison as variation between lots, temperature and other parameters will impact results.

Seitz® K700

The single lot of extract used for analysis of the K700 sheet had an observed solid load of 10%. 6.5 L of this extract was filtered in 322 min resulting in an average flowrate of 20 mL/min (550 LMH). At the end of the filtration a differential pressure of 16 PSI was observed. Turbidity measurements taken at 20 °C ± 5 (68 °F) prior to filtration, were greater than the equipment range and therefore could not be measured. Post filtration the turbidity measured 15 NTU. This value of 15 NTU remained constant throughout the filtration of the 6.5 L.

Utilizing the scale factor described above, approximately 770 gallons/m^2 can be anticipated under the defined parameters. Temperature and solid load fluctuations from batch to batch will impact the filterability profile of the cannabis extract and in some cases much lower throughputs will be observed.

Seitz K100

The single lot of extract used for analysis of the K100 sheet had an observed solid load of 5%. 6.5 L of product was filtered in 309 minutes resulting in an average flowrate of 21 mL/min (572 LMH) and a differential pressure of 10.5 PSI. Turbidity measurements taken at 20 °C ± 5 (68 °F) prior to filtration was 918 NTU and post filtration measured 15 NTU. This value of 15 NTU remained constant throughout the filtration of the 6.5 L.

Utilizing the scale factor described above, approximately 770 gallons/m^2 can be anticipated under the defined parameters. Temperature and solid load fluctuations from batch to batch will impact the filterability profile of the cannabis extract and in some cases much lower throughputs will be observed.

Conclusion

Lack of proper clarification can lead to several bottlenecks throughout downstream processing as well as lower than expected potency levels. Pall Corporation worked closely with cannabis oil producer, Helderpad to integrate an inline, scalable solution for clarification. The SUPRA product family comes in several grades and sizes allowing for a custom solution sized to optimize your specific process. In order to better understand the question of anticipated throughputs through the SUPRA filters, Pall Corporation and Helderpad partnered on a joint trial utilizing unfiltered cannabis extract and Pall Corporation's sheet filters.

Two filter grades were evaluated with extract made under manufacturing conditions emulating the typical cannabis oil producer. When the lot of cannabis extract having 10% solids was trialed using Pall corporation's Seitz K700 media grade, a value of approximately 770 gallons per m^2 could be extrapolated using the scale factor detailed above. When the lot of cannabis extract having 5% solids was trialed using Pall corporation's Seitz K100 media grade, a value of approximately 770 gallons per m^2 could be extrapolated using the scale factor detailed above.

There are several factors producers should consider as they compare their process to what is detailed in this paper.

1. Ratio of ethanol to biomass
2. Length of contact time ethanol interacts with biomass
3. Temperature of ethanol used for extraction
4. Possible sources of shearing forces resulting in submicron particles
5. Prefiltration prior to sheet filters

Pall Corporation would be happy to discuss your process and see how we can help answer any filtration questions you may have.

Pall Corporation does not support, encourage or promote the use of its products or services in connection with any illegal use, cultivation or trade of cannabis or cannabis products. Pall products are intended to be used for cannabis related purposes only in compliance with all applicable laws in a manner that promotes public safety and/or in connection with any lawful and approved scientific or research activities.

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