

APPLICATION NOTES



Temperature Control for
**High-Quality
Cannabis Extractions**

The Equipment and Information You Need for Extraction and Post-Extraction Processes

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T E M P E R A T U R E C O N T R O L

Key Takeaways & Objectives

- ✓ Explore how temperature affects extraction yields, quality, and profits.
- ✓ Understand the equipment needs for ethanol vs. hydrocarbon extractions.
- ✓ Learn how to produce and reproduce high-quality extracts by managing temperatures during the pre-extraction, solvent extraction, and post-extraction processes.
- ✓ Find the equipment you need to eliminate potential risks and streamline your workflow for increased efficiency and regulatory compliance.
- ✓ Discover the equipment you'll need to manage temperatures throughout the extraction workflow.
- ✓ Discover the post-extraction steps and refining processes needed for ethanol and hydrocarbon extractions.



Temperature Control for
High-Quality Cannabis Extractions

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Introduction

The market for hemp and cannabis extracts is booming. Solvent extractions using ethanol and hydrocarbon solvents (butane and propane) continue to be a fast and economical way to extract the desired cannabinoids from plant material. Popular products, including vape oils, edibles, capsules, creams, topicals, and more, rely on consistent, reproducible cannabis extractions, guided by careful temperature and climate management.



SOLVENT EXTRACTIONS ARE A
FAST AND ECONOMICAL WAY TO
CREATE VARIOUS MEDICINAL AND
RECREATIONAL PRODUCTS.

Control of extraction variables is essential for maximizing throughput and yields, ensuring product quality, and increasing profit margins. Whether you're producing products for medicinal or recreational use, it's necessary to know how to maintain temperatures for batch-to-batch consistency throughout the extraction and post-extraction processes. Time is money in the competitive cannabis market, so knowing how to eliminate temperature variables is critical to your quality control, production protocols, and regulatory compliance. The following information will help you save time and money by outlining the basic application processes and the equipment you'll need to succeed with cannabis extractions.

Application Overview

Temperature control is critical in every aspect of the cannabis extraction workflow, from pre-extraction to processing and post-processing refinement. Chillers, low-temperature circulators and heating circulators work together to manage temperatures throughout the extraction workflow.

SOLVENT EXTRACTIONS

Extracting targeted compounds and cannabinoids using ethanol or hydrocarbon solvents (butane and propane) requires various temperature control units (TCUs) and temperature ranges. For ethanol extractions, you'll need a chiller or low-temperature circulator to cool the ethanol solvent to $\leq 20^{\circ}\text{C}$ to achieve optimal terpene and cannabinoid extraction and limit the amount of wax and fat dissolution. Hydrocarbon extractions require even lower temperatures, as low as -60°C ; they also require a heating circulator to facilitate hydrocarbon evaporation. Temperature directly affects yields, quality, timing, potency, purity, and consistency. Various low-temperature chillers and circulators, temperature control systems, and heating circulators work to control temperatures during solvent extractions.



ETHANOL AND HYDROCARBON EXTRACTIONS REQUIRE CHILLERS TO COOL THE SOLVENT; HYDROCARBON EXTRACTIONS ALSO REQUIRE A HEATING CIRCULATOR.

POST-EXTRACTION REFINEMENT

Post-extraction methods refine the extraction oil and ensure a better tasting, high-quality product ready for consumption. Post-extraction processes vary depending on the desired consumer product, extraction process, and solvent. Post-extraction processes include winterization, decarboxylation, solvent distillation (for ethanol removal), crystallization, and vacuum distillation. These post-extraction steps require various liquid temperature control units with high and low-temperature capabilities. Some products and techniques may also need a vacuum oven to remove residual hydrocarbon solvents (butane and propane).



POST-EXTRACTION PROCESSES REFINE THE OIL AND OPTIMIZE IT FOR CONSUMPTION.

Solvent Extraction Methods & Equipment Needs

ETHANOL EXTRACTIONS

Technically, you can extract with ethanol at room temperature, but it's a slow process and not ideal for mass market production. A room-temperature ethanol extraction pulls out many unwanted plant compounds from the plant material. For example, Rick Simpson Oil (RSO) extractions typically occur at room temperature and yield a product with the desired properties but a poor taste profile.

High-quality extracts, the kind that today's consumer is looking for, require lowering the ethanol temperature to $\leq -40^{\circ}\text{C}$. This low-temperature extraction method significantly reduces the solubility of unwanted plant materials, such as lipids, fats, waxes, and chlorophyll, optimizing the capture of cannabinoids and terpenes. Because the undesired components do not dissolve in the cold ethanol, you won't have to worry about winterizing the oil post-extraction. However, additional post-extraction refinement is necessary, including distillation to isolate the crude extract and recover and recycle ethanol for other batches.

Cooling ethanol to process temperatures takes place in a variety of ways: either pre-cooling EtOH totes in a cold room overnight or cooling in jacketed tanks with a liquid temperature control unit. Careful attention to the quantity of ethanol required per day facilitates the cold solvent based upon centrifuge cycle times. Some centrifuges integrate a cooling loop — these setups use a separate temperature control unit to maintain the solvent at the appropriate cold processing temperature.

EQUIPMENT FOR ETHANOL EXTRACTIONS

ETHANOL EXTRACTIONS REQUIRE LOWERING TEMP TO $\leq -40^{\circ}\text{C}$



PRESTO A80



PRESTO A85



PRESTO W91



PRESTO W92

Solvent Extraction Methods & Equipment Needs Cont.

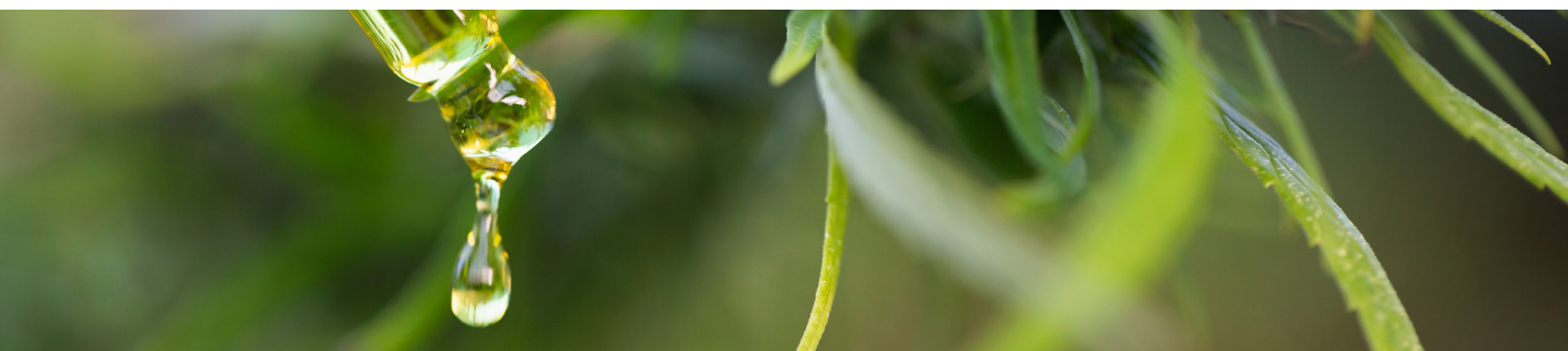
HYDROCARBON EXTRACTIONS (BUTANE & PROPANE)

Hydrocarbon extraction requires pressurized butane, butane/propane, or isobutane mixtures at cold temperatures to reduce the solubility of unwanted plant components. Generally, butane extraction requires temperatures of -40°C , while propane/butane mixtures need -60°C or lower.

The amount of cooling power at these low temperatures varies with the size of the extraction apparatus. There are two main types of temperature control setups for hydrocarbon extractions: an active recovery closed loop system and a passive closed loop hydrocarbon unit.

LIQUIFIED BUTANE, BUTANE/PROPANE, AND ISOBUTANE MIXTURE
MUST BE CHILLED TO $\leq -40^{\circ}\text{C}$ TO MINIMIZE UNWANTED PLANT
MATERIAL EXTRACTION.

1. **An active recovery closed loop system**, which incorporates a compressor pump, requires a primary heat exchanger plus a large chiller. In this method, the hydrocarbon exits the pump at a high temperature ($\geq 100^{\circ}\text{C}$). The preliminary cooling zone removes a lot of heat from the compressed hydrocarbon, enabling the chiller (low-temperature control unit) to condense the solvent into the liquid phase at $\leq -40^{\circ}\text{C}$.
2. **In a passive closed loop system**, you don't have the high heat load from an inline compressor. In this situation, the chiller or low-temperature control unit can condense the hydrocarbon vapor directly to the liquid phase with or without a heat exchanger. Once the pressurized, cold temperature liquid hydrocarbon passes through the plant material column, dewax column, and color remediation cartridge—if installed—the solution enters a lower pressure collection chamber, which causes a phase change (evaporation) from liquid to gas effectively separating the extract from the solvent. The hydrocarbon evaporation causes a temperature drop requiring heating on the jacketed collection chamber to optimize the process. A heating circulator with a moderate temperature of around 60°C generally facilitates this. The heating capacity of the heating circulator depends on the size of the extraction system but can vary from 2kW to 9kW. The vaporized hydrocarbon then recycles through the process.



Temperature Control Equipment for Hydrocarbon Extractions

GENERALLY, BUTANE EXTRACTION REQUIRES
TEMPERATURES OF -40°C , WHILE PROPANE/
BUTANE MIXTURES NEED -60°C OR LOWER.

SMALLER SYSTEMS:

THE AMOUNT OF COOLING
POWER OR COOLING CAPACITY
VARIES WITH THE SIZE OF THE
EXTRACTION APPARATUS.



DYNEO DD-1200F



CORIO CD-BC4

LARGER SYSTEMS:



PRESTO A80



PRESTO A85



PRESTO W91



MACIO MX-BC12



FL20006

Post Extraction Methods & Equipment Needs

WINTERIZATION – FOR HYDROCARBON EXTRACTIONS

High-quality hydrocarbon extractions require a winterization process to remove fats, lipids, and waxes. Making a concentrated extract solution in ethanol at room temperature and cooling it to $\sim 20^{\circ}\text{C}$ lowers the solubility of these components, causing them to precipitate.

METHODS TO CONDUCT WINTERIZATION INCLUDE:

- Placing the solution in a jacketed vessel or filter reactor
- Cooling it with a low-temperature control unit
- Filtering it once the materials have settled out

EQUIPMENT FOR WINTERIZATION



PRESTO A80



PRESTO A85



MAGIO MX-2500F



PRESTO A45

DOWNLOAD THE APP!

Additionally, the JULABO USA App allows you to find chillers based on your application, including temperature ranges, time-to-temperature, and more.



Post Extraction Methods & Equipment Needs Cont.

SOLVENT RECOVERY – FOR ETHANOL EXTRACTIONS

While you can usually skip the winterization process for ethanol extractions, you won't want to miss the solvent recovery phase. Ethanol extractions produce a large volume of ethanol extract solution. Using a falling or rising film evaporator, you can remove the bulk volume of ethanol and recycle/reuse the solvent again.

Falling or rising film evaporators are effective because the extract has a short contact time with the heating zone and the condenser cools via a large chiller. For subsequent processing steps the falling film residue remains too high in ethanol percent (~5-8%) so many times the falling film residue undergoes a 'fining' distillation in a rotary evaporator to bring the ethanol content even lower. Recirculating chillers sized appropriately affect the rotary evaporation distillation with condenser temperatures typically 0 °C to -10 °C.

Post winterization solutions undergo ethanol removal via rotary distillation as described above.



▶ Visit www.JULABO.us for more recommendations!



FL4003



FL7006



FL20006



ACWC-90-Q



ACWC-180-E



ACWC-240-E



Post Extraction Methods & Equipment Needs Cont.

DECARBOXYLATION – FOR ETHANOL & HYDROCARBON EXTRACTIONS

Decarboxylation converts the acid cannabinoid forms (CBDA | THCA) to the active compounds CBD | THC. This chemical reaction/rearrangement requires heat to expel the CO₂. Although the process sounds like a mouthful, it's simple in practice. Once you have a solvent-free extract, you'll want to heat it to >100 °C (temperatures vary depending on processors) in a jacketed reactor. Decarboxylation concludes once bubbling from the evolved CO₂ ceases. Heating circulators provide the heat for the process. The exact heating power or capacities you'll need depend on the size of the reactor.

EQUIPMENT FOR DECARB



MAGIO MX-BC12



MAGIO MX-BC12 HST



MAGIO MX-BC26



PRESTO A45T



Post Extraction Methods & Equipment Needs Cont.

DISTILLATION

The crude extract (typically dark brown) from the decarboxylation process requires refinement before formulation into consumer products such as vape cartridges or edibles. Given that cannabinoids have a high boiling point, vacuum distillation equipment comes into play, and lowering the pressure also lowers the boiling point.

VACUUM DISTILLATION EQUIPMENT COMES IN TWO VARIETIES, BATCH AND CONTINUOUS:

1. **Batch systems:** short path and wiped (or rolled) film distillation systems heat the crude extract to the boiling point using either a heating mantle (typical for short path systems) or jacketed distillation vessel. Jacketed systems require high-temperature heating circulators to provide temperatures $>100^{\circ}\text{C}$. Since the CBD or THC distillate has a high boiling temperature, the condenser also requires an elevated temperature to condense the vapors and allow the distillate to flow into collection vessels. The condensers need refrigerated/heating circulators to remove heat and convert the vaporized cannabinoids into liquid.
2. **Continuous wiped or rolled film distillation apparatus come in various sizes depending on the required throughput.** These systems include many zones that require heating circulators to keep the crude distillate flowing to the distillation body. Given that this process requires very low pressure, vacuum pumps (turbine or oil diffusion pumps) need protection from vapors by use of a cold vacuum trap. Trap cooling uses either low-temperature immersion coolers or, more sophisticated traps, coil/jacketed traps, which use an ultra-low refrigerated circulator. Processors can produce high purity isolate (CBD or THC) of $>95\%$ purity with optimized parameters (vacuum, temperature, flow rate). The resultant high purity isolate moves on for formulation into consumer goods.

EQUIPMENT FOR DISTILLATION



Workflow Considerations, Challenges & Solutions

HOW TO MANAGE MOISTURE ACCUMULATION

Recirculating chillers can experience moisture accumulation in the bath fluid due to the condensation of atmospheric moisture. Moisture build-up can lead to performance problems and unwanted downtimes to address the excess water in the bath fluid. You'll want to use a low-temperature circulator with a condensation trap lid to prevent this from slowing down your processes. Additionally, the cold-oil overlay technique implemented in JULABO's PRESTO™ units eliminates moisture build-up in the bath fluid.

HOW TO MAINTAIN HEAT SET POINTS

Equipment manufacturers size heating circulators for hydrocarbon collection tanks based on a suggested throughput. If a processor decides to push beyond the standard throughput, the heating circulator could struggle to maintain the set temperature; meaning it requires more heating capacity to keep up. The SL-12 3kW heating circulator can easily extend its heating power with the addition of a booster heater, which increases capacity by an additional 6kW.

HOW TO HANDLE INCREASED TEMPERATURES DURING DISTILLATION

Condenser cooling on rotary evaporators provides adequate cooling at the desired temperature (0 °C to -10 °C) based on the vessel size (5L, 20L, 50L, or 100L) and standard distillation rate. If the chiller temperature increases, this typically indicates an increased distillation rate causing the temperature to increase as the chiller has higher cooling power at warmer temperatures. If this occurs, lowering the distillation rate will enable condenser stabilization at the desired condenser temperature or will require a chiller with the increased cooling capacity to keep up with the increased distillation rate.

HOW GMP (GOOD MANUFACTURING PRACTICES) CAN HELP

Manufacturers seek a competitive edge as the CBD and recreational THC markets mature nationally or within legalized states. By implementing GMP or cGMP standards, processors can gain a competitive advantage. GMP practices raise consumer confidence in the products and ease relations with regulators. Facilities that implement GMP must keep detailed records and conform to thorough SOPs. Liquid temperature control units with IQ/OQ options, data-recording, and I/O to PLCs or PCs for data-logging work well with GMP protocols.



Conclusion

Sizing matters. As processors feel ownership and/or market pressure to increase production and meet price targets, the drive to go bigger remains very real. This has a trickle down effect on the equipment requirements throughout the extraction workflow. For ethanol extraction, larger volumes of solvent will necessitate stronger low temperature chillers. In hydrocarbon extraction, the rate of solvent phase change ultimately determines the maximum daily throughput, which requires stronger low temperature circulators. Post extraction processing unit operations need adjustment with either larger equipment or additional workstations to accommodate the increased throughput.

Next Steps

FINDING THE EQUIPMENT MANUFACTURERS AND ASSISTANCE YOU NEED

Cannabis extractions require numerous steps and processes to produce high-quality products. Regardless of the solvent (ethanol, butane, propane, etc.), extraction requires various climate and temperature control tools to manage the process. Sizing the appropriate temperature control equipment requires expert assistance. JULABO USA has the expertise to provide cannabis processors with the necessary equipment, information, and sizing support.

-  Quick shipping and delivery
-  2-year warranty plus extended coverage
-  Virtual and in-person training and support
-  Extended service hours, web chats, installations, and training
-  In-house service technicians and additional service providers across North America
-  NRTL, UL/CSA marked units
-  German-engineered products

For personalized product recommendations and application assistance, please reach out to JULABO USA directly:



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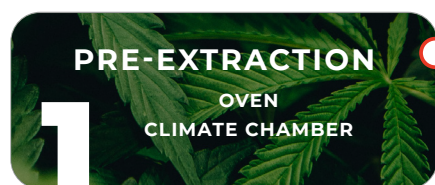


JULABO USA & MEMMERT USA have combined their expertise to provide you with the information and equipment you need to manage your extraction workflow. Together, we have the temperature control equipment you need for high-quality extractions.

PURCHASE FROM:

EQUIPMENT NEEDED FOR CANNABIS EXTRACTION

• JULABO USA ■ MEMMERT USA



EQUIPMENT FOR EVERY STEP & PROCESS

PRE-EXTRACTION



DRYING | ■
Prepare the plant material for extraction by removing excess moisture.



CURING | ■
Fine-tune the moisture content and age the plant material for an optimal experience.

EXTRACTION



SOLVENT EXTRACTION | ■ ●
Use ethanol or hydrocarbon solvent to extract the desired cannabinoids.

POST-EXTRACTION



WINTERIZATION | ●
Remove residual fats, lipids, waxes, and other compounds.



SOLVENT RECOVERY | ●
Recover & recycle ethanol and isolate the crude extract.



DECARBOXYLATION | ■ ●
Apply heat to convert inactive compounds such as CBDA & THCA into active compounds (THC & CBD).



DISTILLATION | ●
Isolate smaller quantities of high purity terpenes and cannabinoids.



VACUUM DRYING | ■
Further remove residual solvents (butane, propane) through vacuum heating.

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HEATING CIRCULATORS**



**RECIRCULATING
CHILLERS**

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**VACUUM
OVENS**



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