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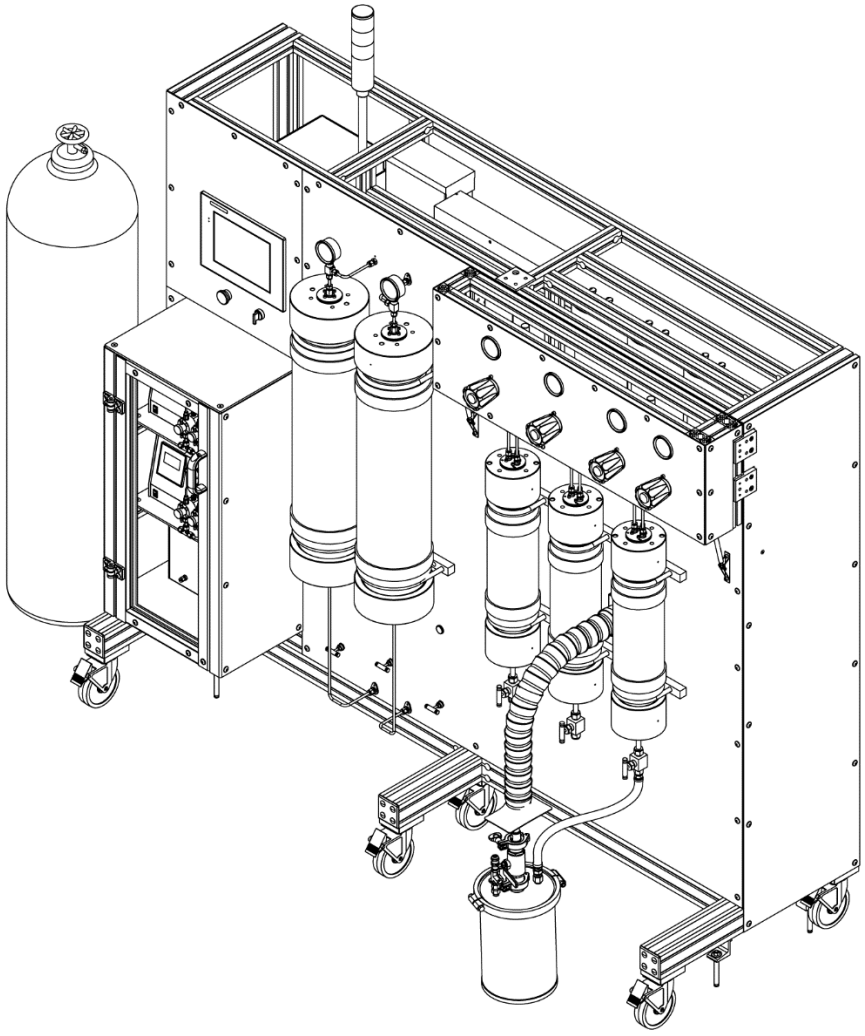
United Science Corporation
931 Pine Street
Saint Croix Falls, WI 54024-9006

Supercritical Fluid Extraction System
Operating Manual



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General Information

Copyright Notice

Sufficiency of Documentation

No document set is perfect. If any discrepancy in documentation is evident to the customer, the customer is responsible for notifying the manufacturer of the discrepancy and obtaining clarification or correction. Signing off on installation documentation is a declaration of acceptance of the sufficiency of documentation and conformance to specifications.

Trademarks

ExtraktLAB® is a registered trademark of United Science LLC
United Science® is a trademark of United Science LLC
CarbonX® is a trademark of United Science LLC
All other trademarks or registered trademarks are the sole property of their respective owners.

Customer Comments

We invite customer and users to offer suggestions, edits or any other feedback that will help us provide a better experience.

Audience and Purpose

This guide is intended for use by individuals who install, operate, or maintain the CO_2 system. It gives an overview of the technology and operation of the CO_2 system.

Intended Use of the CO2 System

United Science designed the CO2 system with recycler for use as a supercritical CO_2 extractor.

Contacting United Science

Contact United Science with technical feedback or technical questions regarding the use, transportation, removal, or disposal of any United Science product. You can reach us via the

internet, telephone, or conventional mail.

United Science Contact Information

Table 1. Contact Information

Contact		Information
Internet		www.unitedsciencecorp.com
Telephone and fax		From the USA or Canada, phone 651.464.2822
Conventional mail		United Science 24260 Greenway Ave Forest Lake, MN 55025 USA

Conformity to Standards

Table 2. Table of Standards.

Item	Description
1	NFPA 79
2	ASME VII-2
3	FDA CFR 21 Part 11 211.36/211.67a

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Manufacturer's Declaration of Conformity

MANUFACTURER'S DECLARATION OF CONFORMITY

United Science LLC
931 Pine Street
Saint Croix Falls, WI 54024

DECLARES UNDER OUR SOLE RESPONSILITY THAT THE FOLLOWING EXTRACTION PRODUCT:

MODEL NUMBER: Extrakt-110/120

IS IN CONFORMITY WITH THE FOLLOWING STANDARDS AS FAR AS THEY ARE APPLICABLE:

NFPA 79
ASME VII-2

FOLLOWING THE PROVISIONS OF:

LOW VOLTAGE DIRECTIVE 2006/95/EC
EMC DIRECTIVE 2004/108/EEC
ROHS 2 DIRECTIVE 2011/65/EU
WEEE 2 DIRECTIVE 2012/19/EU

Jack Swonger, P.E.
Process Engineering Director

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Identified Hazards

Safety Hazard Symbol Notice

Documentation needs to be consulted in all cases where the symbol is used to find out the nature of the potential hazard and any actions which have to be taken.

Fire Hazard

WARNING: To avoid fire or explosion caused by leakage of flammable coolant from the chiller, inspect the CO_2 recycler for leaks before allowing unattended operation.

Eye Protection

WARNING: To avoid eye injury from possible failure of seals or fittings, wear eye protection while near the device.

Requirement: Wear eye protection while near the device.

Foot Protection

WARNING: To avoid foot injury from potential accidental falling of heavy cap nuts, wear foot protection while servicing the device.

Requirement: Wear foot protection while servicing the device.

Frostbite Hazard

WARNING: To avoid injury associated with coming into contact with extremely cold surfaces, exercise caution when accessing any CO_2 recycler component, the internal and external surfaces of which can become extremely cold during normal operation.

Rapid Decompression Hazard

WARNING: To avoid frostbite and other injuries associated with the sudden release of rapidly expanding fluids, observe these precautions:

- Depressurize the system before attempting to change or work with the bulk fluid supply.
- Exercise caution when opening fittings, to avoid being sprayed by rapidly expanding solvents.
- Fit supply lines made only of materials that can suitably withstand the highest pressure that the system can generate.

Other Safety Notifications

General CO_2 Safety Notice

CO_2 and organic solvents that are used to extract and clean biomass or other media may pose several unique hazards including the risk of asphyxiation, freezing, rapid gas expansion, electric shock, and toxicity. Consult this manual, your organization standard operating procedures, and CGA and IGC guidelines for CO_2 usage, personal protective equipment, and toxicity warnings.

Carbon Dioxide Handling

WARNING: User must be familiar with the dangers of carbon dioxide.
CO_2 becomes toxic at levels above 10,000 ppm with an exposure limit of 5000 ppm.

WARNING: Frostbite hazard can occur from release of pressurized CO_2 to atmosphere or contact with accumulated dry ice at a leak site. Gloves and glasses required.

WARNING: Asphyxiation hazard caused by displacement of oxygen.

Requirement: Engineered room venting shall comply with local codes and mechanical engineering design and compliance with installation instructions.

Requirement: Detection of ambient CO_2 level and alarm at permissible exposure limit (5000 ppm over 8 hours)

Requirement: Customer shall install safety CO_2 detection and oxygen sensing devices to detect and alarm a potential hazard.

Requirement: Equipment must be connected to earth ground to prevent shock.

OSHA, the Occupational Safety and Health Administration agency has set a Permissible Exposure Limit for CO_2 of 5000 ppm or 0.5%. The American Conference of Governmental Industrial Hygienists (ACGIH) has also set a Threshold Limit Value of 5000 ppm. This

represents the time-weighted average (TWA) CO_2 concentration that personnel may be exposed to during a normal eight-hour workday. Additionally, the ACGIH recommends a maximum Short-Term Exposure Limit of 30000 ppm (3%) for 15 minutes.

Where the potential exists for exposure to CO_2 above the allowed limits, monitoring devices and good ventilation are recommended to maintain oxygen levels at 19.5% and less than 5000 ppm CO_2.

Proper Handling, Storage, and Disposal of Chemicals

WARNING: Familiarize yourself with proper handling, storage, and disposal of all chemicals used with your system. Refer to the Material Safety Data Sheet (MSDS) for each coolant or chemical, and know its chemical properties.

Biohazard Warning

WARNING: Materials extracted with this extractor may contain biohazards such as toxins, microorganisms, or biological fluids. Observe precautions and consult your laboratory protocols for handling biomass.

Interlocks

NOTICE: To avoid unexpected decompression at identified interlock points, ensure the system including interlock points are fully vented before servicing.

FCC Radiation Emissions Notice

Changes or modifications not expressly approved by the party responsible for compliance, could void the user's authority to operate the equipment. This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Equipment Misuse Notice

If equipment is used in a manner not specified by its manufacturer, protections against personal injury inherent in the equipment's design can be rendered ineffective.

Personal Protective Equipment

NOTICE: Wear appropriate personal protective equipment when working with any type of hazardous chemical.

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The following is a list of personal protective equipment necessary for safe operation of the extractor.

- Face Shield
- Nitrile Gloves when working with extracted material
- Lab Coat or Apron
- Steel Toe Shoes

Cleaning Spare Parts and Consumables

It is the responsibility of the customer to adhere to customer's critical clean standards. This means that every consumable or process part must be cleaned using the customer's protocols and accept criteria for cleaning before it is put into service.

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Safety Symbols and Warnings

Table 3. Safety Symbol Table

Number	Symbol	Reference	Description
1		OCE-1760	Compressed air warning
2		OCE-16486	High pressure, venting required
3		ANSI Z535.4	Compressed gas warning
4		ISO 3864-2	Caution, hot surface
5		ANSI Z535.2	Burn hazard, hot surface
6		ISO 3864-2	Body crush/tip over hazard
7		OSHA 1910.145(f)(2)	High voltage present

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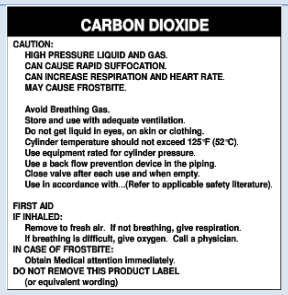
8		ISO 3864	Face shield required
9		ANSI Z535.4	Disconnect power supplies before cleaning or servicing
10		ASTM D 2979	Emergency stop location
11			Electrical safety inspection
12			This symbol alerts you to a wide range of potential dangers
13			This symbol advises you of danger from electricity or electric shock
14			This symbol indicates a protective conductor terminal.
15	INTERLOCK Vent before servicing	CUSTOM	This label is placed on tubes that are interlocked.
16		CUSTOM	Label notifying users of the dangers of carbon dioxide.

17		ISO standard	Pinch point warning
18		ISO standard	Gloves Required

EMC Considerations

Canada Spectrum Management Emissions Notice

This class A digital product apparatus complies with Canadian ICES-001.
Cet appareil numérique de la classe A est conforme à la norme NMB-001.

ISM Classification: ISM Group 1 Class A

This classification has been assigned in accordance with IEC CISPR 11 Industrial Scientific and Medical (ISM) instruments requirements.
Group 1 products apply to intentionally generated and/or used conductively coupled radio-frequency energy that is necessary for the internal functioning of the equipment.
Class B products are suitable for use in both commercial and residential locations and can be directly connected to a low voltage, power-supply network.

Documentation

The procedures and documents referenced in this document are listed below.

Table 4. Table of reference documents.

Factory Acceptance Tests *(FAT)		
Procedure Number	**Name**	**Function**
CP-020	Factory Acceptance Test Plan	Lists all the tests, documents, and actions to be completed for a FAT test
CP-015	High Temperature Limit Test	Tests the performance of the heaters and ability of max temperature setting to turn off heaters.

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CP-008	Temp Switch Safety Switch Test	Tests the reliability of the thermal switch safety circuit.
CP-009	CO_2 Pump Shut-off Test	Tests the CO_2 leak pump and valve shut off mechanism.
CP-010	CO_2 Outage Test	Tests the ability to detect CO_2 outage.
CP-009	High Pressure Pump Shut-off Test	Tests the high pressure pump cut off mechanism.
CP-012	Post Pressure Pump Shut-off	Tests the ability to detect a clog in the post collector.
CP-004	Pressure Relief Testing	Tests relief valve setting on containment and post collector.
CP-014	Inlet Temperature Pump Shut-off Test	Tests the ability to detect a chiller fault.
CP-013	Diagnostic Alarms Test	Tests the ability of the instrument to display an alarm in the event of a fault.
CP-016	Normal Operation Signal Functionality Test	Tests the ability of the system to signal method events.
Site Acceptance Tests (SAT)		
CP-017	Visual Inspection	Inspection check list for shipping damage
CP-019	SAT Test Plan	Test plan for site acceptance testing.
QP-002	Installation Site Compliancy	Installation of site compliancy for supercritical CO_2 extraction systems and records the results of instrument calibration procedures.
CP-018	Functional Test	Tests functionality of equipment upon installation.
Scheduled Maintenance Procedures		
MP-001	Solvent Pump Maintenance	Describes how to maintain and repair problems with the solvent pump.

MP-002	CO_2 Pump Maintenance	Describes how to maintain and repair problems with the CO_2 pump.
MP-004	BPR Rebuild Procedure	Describes how to rebuild back pressure regulators, install new seals and seats.
MP-003	Chiller Maintenance	Describes procedures used to maintain chiller performance
MP-005	Terpene Carbon Cleaning	Describes cleaning of the terpene collector.
MP-006	LEWA Diaphragm Replacement	Describes replacement of LEWA pump head diaphragm
MP007	MP-007 Swagelok SK Valve Rebuild Procedure	Describes replacement of seals within Swagelok SK valves
See Manufacturer Manual	CO_2 Meter Calibration	Follows manufacturer's recommendation for CO_2 meter service.
Cleaning Procedure		
WI-001	Routine Cleaning Procedures	Describes cleaning schedule, validation procedures, and methods.
Work Instructions		
WI-006	Making and Breaking Swage Connections	Instructions for correctly connecting Swagelok tubing to seal and unseal the pressure fittings on the extractor
External Reference Documents		

Polyscience 6260 Chiller Operator Manual
Swagelok Fitting Install Procedures
Tescom Safety Installation, Operations & Service Manual
CGA G-6 2009 7th Edition
CO2 Meter User Manual

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Technical Description

Overview

United Science Supercritical CO_2 Extractor uses carbon dioxide (CO_2) at an elevated temperature and pressure to extract soluble compounds from natural products. Carbon dioxide above the critical temperature (31 °C) and pressure (1071 psi) becomes a supercritical fluid, which has an increased capacity for solubilizing non-polar compounds. Raising the temperature and pressure of the liquid CO_2 can lead to efficient extraction of matter in a short period of time. The extractor utilizes an extraction vessel into which plant matter is loaded, and through which supercritical CO_2 is then pumped. A backpressure regulator is used to control the pressure, and at the exit of that backpressure regulator the pressure is lowered into the first collection tank. Supercritical fluid exiting the extraction tanks expands into a collection vessel. As the CO_2 pressure decreases, the solubility of the dissolved constituents decreases subsequently precipitates. This first collection step is followed by subsequent lower pressure collection steps which continues to precipitate dissolved matter. Finally, the CO_2 is either sent through a post collector to ensure all oil is collected or is shunted to the recycler system.

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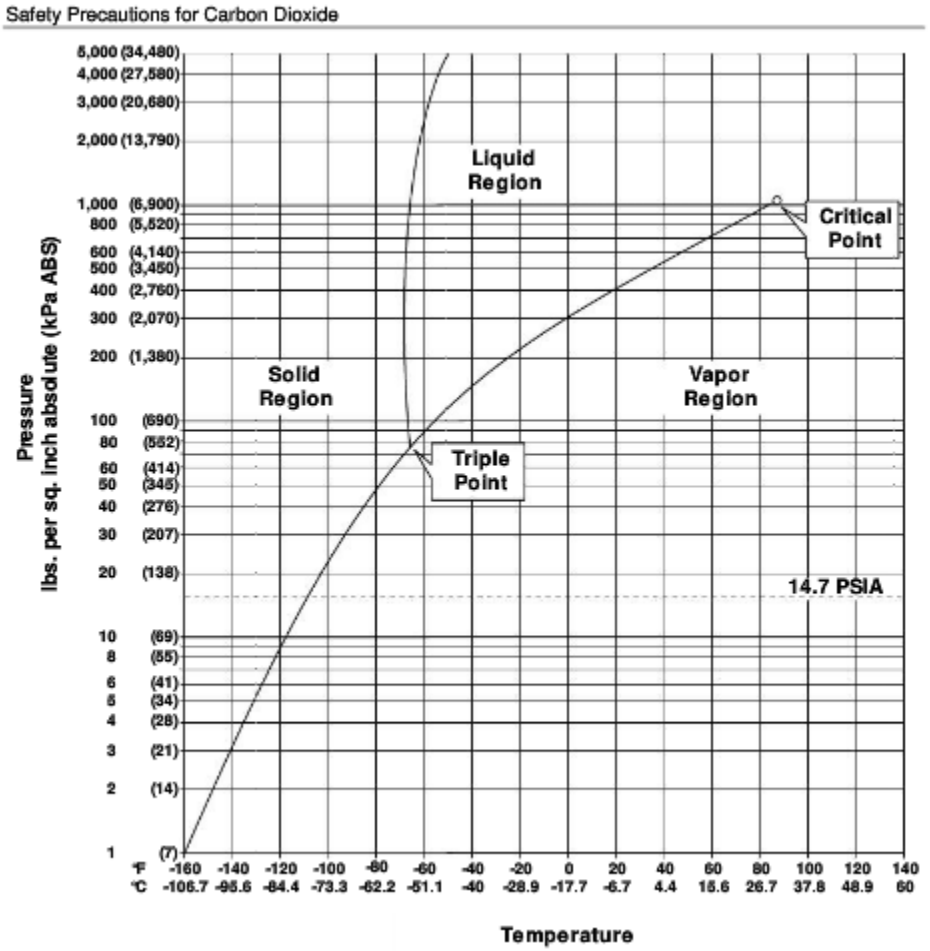

Figure 1. Phase diagram for carbon dioxide.

Flow Path Through System

The following block diagram shows the major functions of the extractor and recycler:

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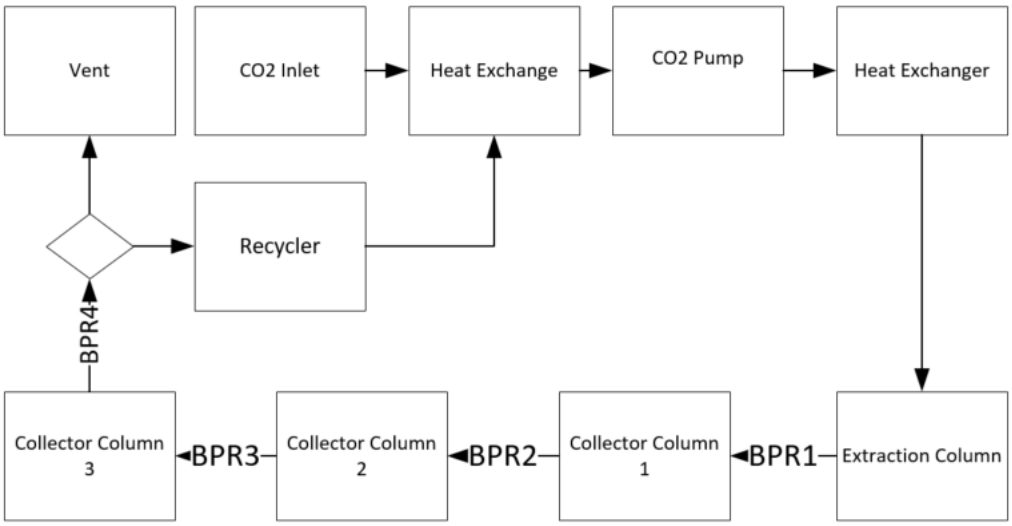

Figure 2. Unit operations

In this scheme, CO_2 enters the system at the CO_2 Inlet as a liquid at room temperature and is conveyed through piping to a heat exchanger. The Heat Exchanger cools the fluid down to -5^o to 10^{o}C to give an inlet vapor pressure range of 384-684 psi. As long as the inlet pressure significantly exceeds the vapor pressure, the pump will operate as intended. The fluid enters the CO_2 Pump and the fluid pressure is heated in an additional Heat Exchanger. The heated CO_2 is then amplified as the pump pushes the fluid into the first extractor against the first back pressure regulator (BPR1). Once the fluid has filled the extraction column and pressure in the Extraction Column has reached the pressure set by BPR1, the fluid begins to flow into Collector Column 1. The pressure is maintained as a liquid by another back pressure regulator (BPR2) until the fluid reaches the BPR2 set point pressure. The fluid then flows into Collector Column 2 and the process is repeated under the action of BPR3 until the fluid flows into Collector Column 3. The process continues again as the fluid fills Collector Column 3 under the back pressure action of BPR4. The CO_2 is then either vented to the venting system or is shunted to a recycler. The Recycler receives the effluent from the recycler which conditions the fluid to be shunted back into the CO_2 pump.

Major Components

Front View

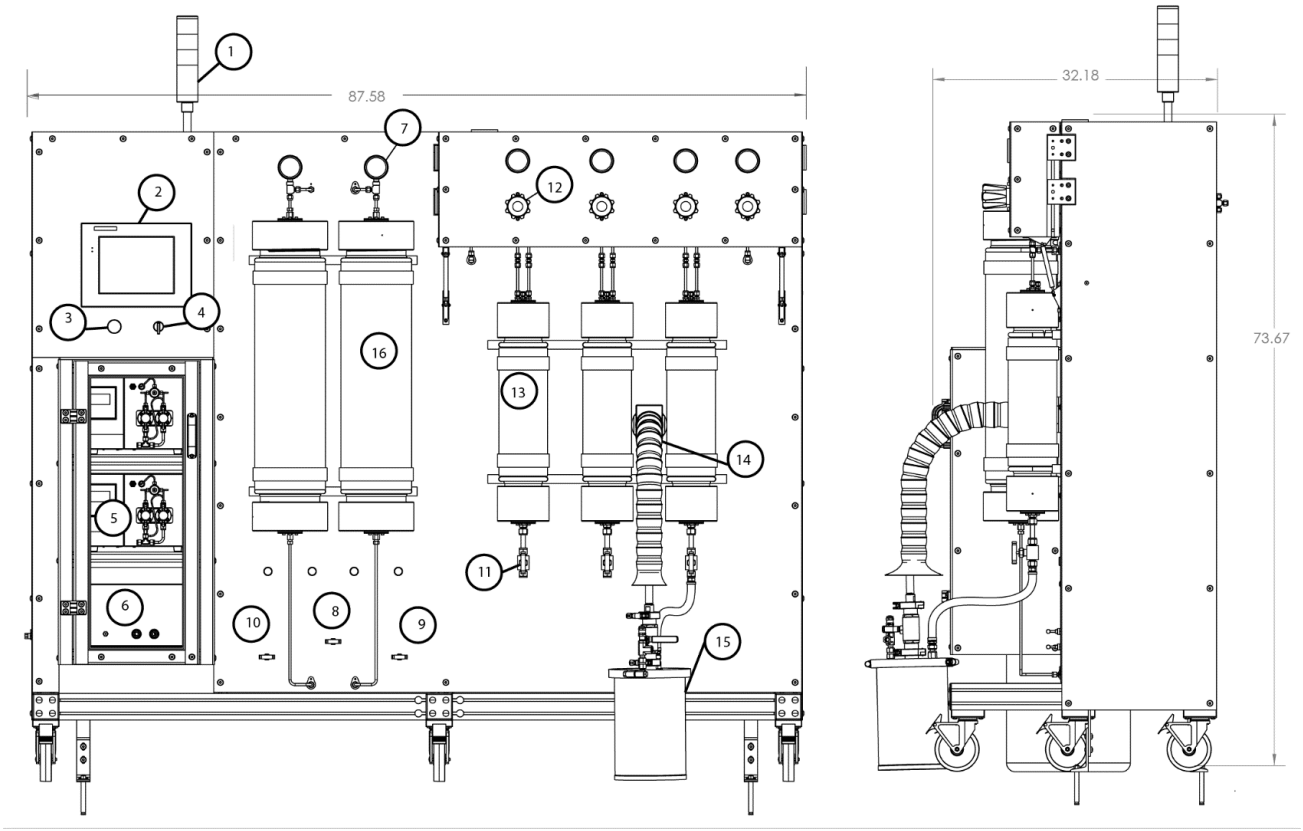

Figure 3. Front and side view of extractor showing the locations of major components.

Descriptions of Components on Front View

Table 5. Component Description for Figure 3

Items	Location	Description
Signal Tower	1	Signals method operations and safety alarms.

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HMI Panel	2	Human machine interface (HMI) touchscreen panel for controlling and programming the instrument.
E-stop	3	Stop button that will shut off all power to the instrument.
On/Off Switch	4	On/off switch that will turn the system on and off.
Pumps	5	Pumps for the pressurization and conveyance of solvents to the process. Cabinet holds one or more pumps.
Heat Exchanger	6	Heat exchanger for chilling CO_2 to pumping temperatures.
Pressure Gages	7	Allows manual monitoring of pressures in each column.
Transfer Valves	8	Manual valve that allows transfer of fluid from one extractor to another.
Vent Valve	9	Manual valve for venting extractor 1 fluid after use.
Vent Valve	10	Manual valve for venting extractor 2 fluid after use.
Collector Valve	11	Manual valve used for venting and removal of oils from collectors.
Back Pressure Regulator Valves	12	Manual valves for setting the pressures of collectors and extractors.
Collector Columns	13	Containers for collecting extracted oils.

Front anti-static Vent	14	Exhausts carbon dioxide from the containment system upon collection event.
Containment System	15	Isolates collected materials in to prevent contamination.
Extractor Columns	16	Contains the materials to be extracted.

Rear View

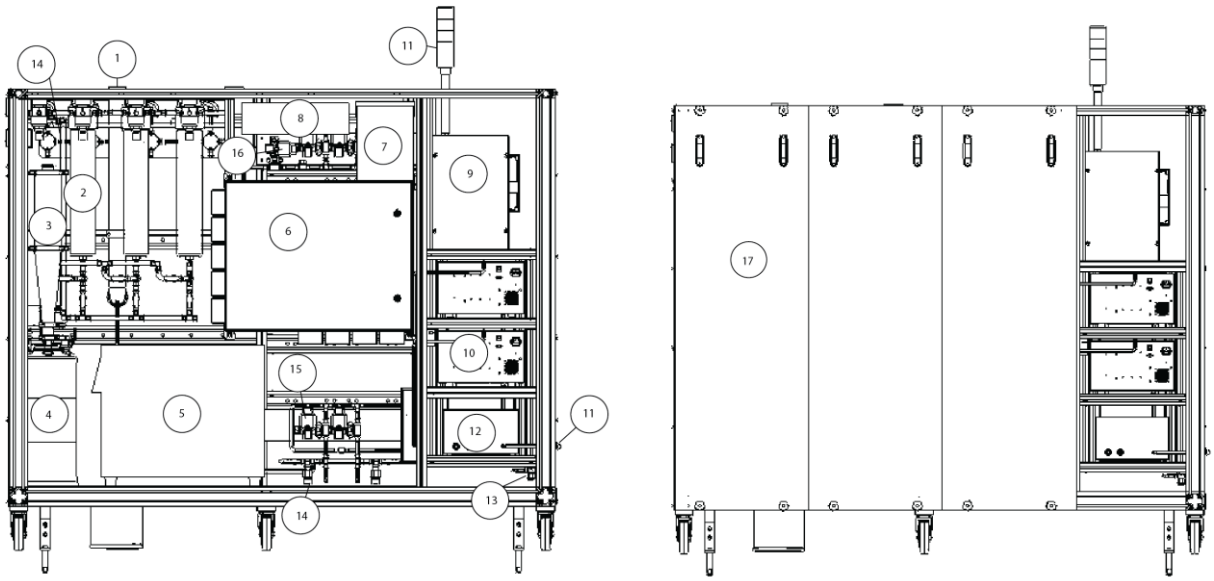

Figure 4. Rear view of extractor.

Description of Components from Rear View

Table 6. Component Description for Figure 4

Items	Location	Description

Vent Conduit Connection	1	Grounded vent fan connection.
Recycler Conditioning System	2	Recycler for conditioning of contaminated CO_2.
Terpene Trap and Vent Sump	4	Sump for trapping volatile effluent components.
Chiller	5	Chiller to provide low temperature fluid to cool effluent and pump heads.
Control Panel	6	Control panel that houses the PLC, output modules, low voltage power supply, solid state relays, and contact relays.
Main Power Breaker and Disconnect	7	Breaker box for main and circuit branch protection.
Pneumatics	8	Pneumatics panel that controls automated valve actuation; also the location of the compressed air inlet.
Contactor Panel	9	Contactor electrical panel and location of main power receptacle.

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Rear View of Pumps	10	Pumps for the pressurization and conveyance of solvents to the process. Cabinet holds one or more pumps.
CO_2 Inlet	11	Swagelok 1/8” inlet bulkhead fitting for connection to CO_2 source.
Heat Exchanger	12	Heat exchanger for conditioning of CO_2.
CO_2 Filter	13	Filter for removing particulate matter from the clean CO_2 stream.
Rupture Safety Discs	14	Burst discs are attached to every column in the system to provide overpressure protection.
Automatic Valves	15	Automatic switching valves for automated runs.
Telemetry and CO_2 Meter	16	WiFi connection and CO_2 meter location.
Back Panels	17	Rear safety panels for protection of equipment.

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Instrument Configuration Options

- Extrakt 110 - CO_2 Pumps single (standard) dual (optional)
- Extrakt 140 - CO_2 Pump by LEWA
- Optional Solvent Pump
- Optional Terpene Collection System
- 5L, 10L or 20L Extraction Columns (2 per system)
- Solvent Recycler

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Installation Requirements

Installation must conform with the requirements set forth in this section. To obtain warranty as specified in the purchase documentation, the customer must complete the required verifications, sign and date the certification document, and return the documents to the manufacturer within 25 days of delivery.

Interface Specifications

Table 7. Interface Specifications

Item	Description	Visual
CO_2 Feed	3/8” compression fitting type Swagelok® Follow WI-006 and manufacturer’s documentation for making and breaking connections.	
Compressed Gas	ColorConnex Push-To-Connect female Green Coupler, ARO Type B 1/4 in. FNPT	
Ventilation Interface	Customer shall provide a vent fan that will provide a minimum of 1000 CFM and vent fan conduit that is antistatic and can interface with a 2” EMT Pipe as per the requirements listed in QP-001 (Extrakt 110 and 110+) or QP-002 (Extrakt 140).	

Electrical Interface	Customer shall provide electrical connections according to installation specifications QP-001 (Extrakt 110 and 110+) or QP-002 (Extrakt 140).	

Carbon Dioxide Quality Requirements

Carbon Dioxide shall conform to CGA specifications for food grade CO_2 or better as defined in CGA G-6.2-2011 or equivalent international standard.
Lot certifications shall be obtained by customer and attached to the batch record.

! NOTICE: To prevent cross contamination, supplier shall certify that the tanks have been inspected and autoclaved in accordance with CGA G-6.3_4 or equivalent international standard.

! **NOTICE: All CO_2 cylinders shall be anchored to the wall in accordance with applicable local and national safety standards.**

Carbon Dioxide Supply

The system can be charged using a 50 or 100 lb CO_2 cylinder equipped with a diptube and a CGA 320 fitting. There are several CO_2 supply options available to the customer.

- First, a single or ganged cylinder installation kit is included in the standard installation. Change out of the tanks is manual and change out rate depends on usage.
- Second, cylinder bundles are available from United Science. Cylinder bundles are comprised of 16-100 lb tanks that are pre-plumbed so that connecting 16 tanks only requires one disconnect fitting. They can be moved with a forklift or pallet jack for easy switching and filled at either the customer site or at the CO_2 supplier site.
- The third option is to install a large bulk tank with a recirculation pump to feed the extractor. United Science can provide a proposal for these options at the customer request.

Installation

! NOTICE: Equipment is not to be positioned so that it is difficult to access the power

receptacle, main breaker panel, or the Estop.

NOTICE: Retain packaging until unit is completely installed.

Installation Kit

An installation kit is provided with your instrument that has all of the necessary items for instrument start-up. The installation kit packing slip is included with the shipment of your instrument. Please verify the completeness of contents. If any item is lost or missing, contact the factory immediately.

Disassembly of Shipping Crate

WARNING: Do not attempt to lift crate. Spinal injury may result. Follow your company's procedures and practices regarding safe lifting and relocation of heavy objects.

WARNING: De-crating requires proper PPE including hard hat, gloves, eye protection, and foot protection.

NOTICE: More than one person is required to disassemble the crate.

NOTICE: No returns accepted. Unit may be warranty repaired if it is found to not conform to manufacturer specifications. If the unit is damaged or does not operate properly, please contact the transportation company and file a damage claim.

Space Requirements for Unpacking and Installation

- Unpacking requires a space that is at least 300" x 300".
- Floor must be level and smooth.
- The instrument is designed for indoor installation in ambient temperatures between 5-30ºC; relative humidity should not exceed 80% noncondensing.

Tools Required for Unpacking

- 5/8 Socket with 3/8" drive
- 3/8" Ratchet drive

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Disassembly Procedure

- Inspect the shipping crate for damage. If damaged, report the damage to your shipping carrier and obtain instructions from them as to how to proceed.
- Remove the top of the crate by unscrewing the lag bolts on the top panel.

! NOTICE: The top panel is heavy. Use caution to remove the overhead panel. Two people are required for this operation.

- Remove the lag bolts on the front panel and allow the drop ramp to pivot into position.
- Locate and inspect the impact sensor. If the sensor shows an impact has occurred, report the damage to your shipping carrier and obtain instructions as to how to proceed.
- Remove the side and back panels by unscrewing the lag blots.
- Take a picture of the unit with the straps attached and attach picture for installation site compliancy documentation.
- Remove the ratchet straps across the top of the machine.

! NOTICE: Ratchet straps may be under tension. Wear PPE when cutting the straps.

- Remove the lag bolts for the lateral movement suppressor beams.
- With a scissor or floor jack, lift each respective side to remove the beams.
- Manually turn the wheels of the unit so that they face down the ramp. Be aware of pinch points.
- Gently, position the unit on the ramp. Restrain the unit from rolling down the ramp quickly. At least two people are required for this operation.

! NOTICE: Insure that the front of the ramp is unobstructed. Proper clearance must be provided on all sides so that the unit will not encounter any objects as it rolls off the ramp.

WARNING: To avoid injury, ensure no objects are in the path of the wheels and that there is enough room to prevent any crush accidents.

- Once the system is off the crate, retain the crate until completely installed
- Move the unit to the approved and prepared location.

NOTICE: Floor must be level to move the unit. If the floor is not level or smooth, the unit may suffer damage.

WARNING: To avoid injury, do not allow unit to encounter an incline during transport. The floor must be level and smooth.

- Remove protective plastic wrapping.
- Remove boxes from the crate and instrument containing the installation start-up kit components by removing the back panel and unpacking the boxes.
- Verify that nothing is broken.
- Obtain the packing slip for the installation kit and verify completeness.

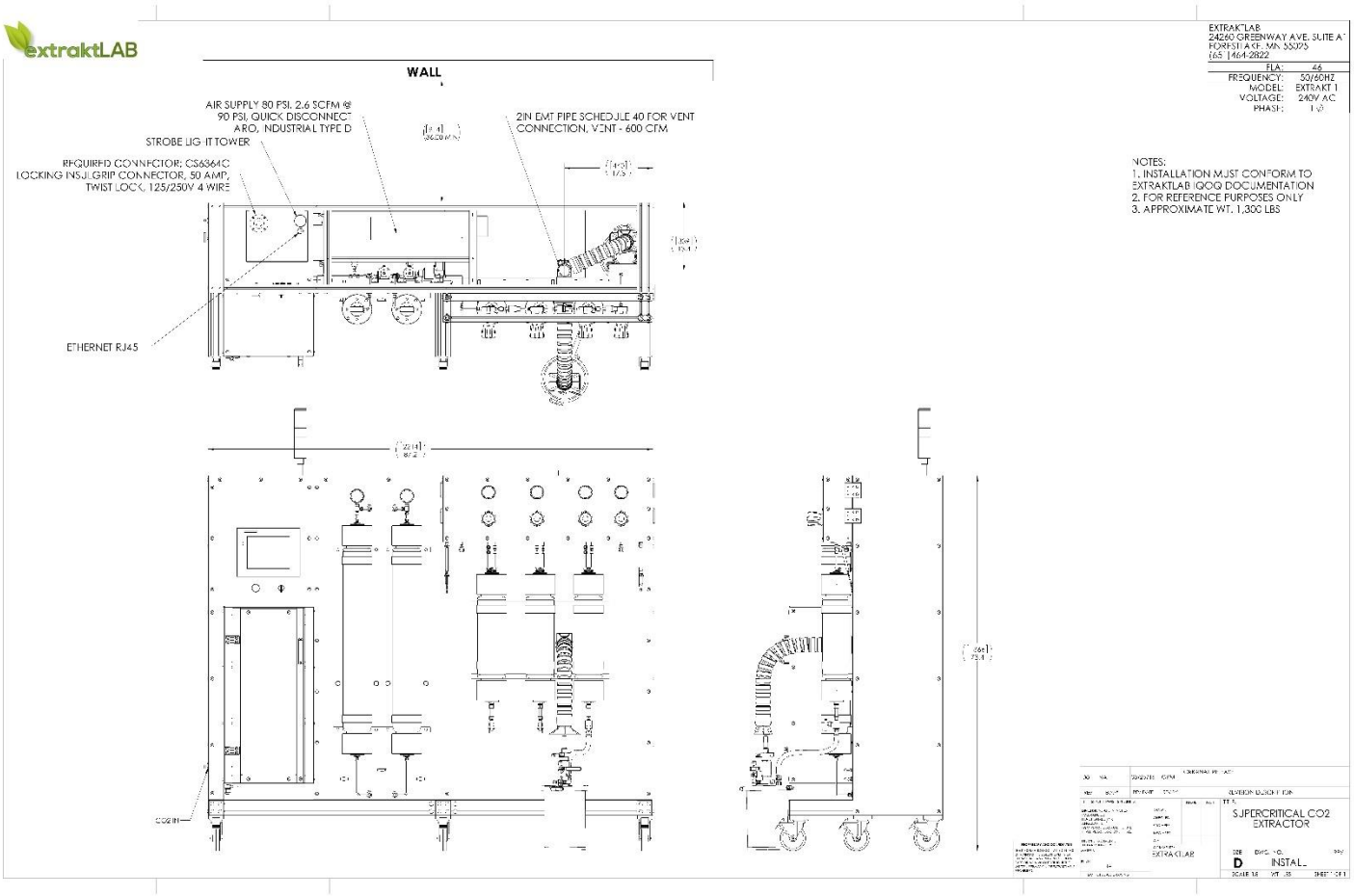
Site Requirements for Final Extractor Installation Location

- Please refer additionally to QP-001 (Extrakt 110) or QP-002 (Extrakt 140) located in CP-019 Site Acceptance Test Plan (Extrakt 110) or CP-22 Site Acceptance Test Plan (Extrakt 140).
- The equipment should be located on a level surface.
- Instrument should not be installed near a heat source.
- Should be located near a suitable drain.

Please refer to the installation drawing for more information.

Installation Drawing

Obtain a up to date installation drawing as provided with the equipment.



Environmental Specifications

Table 8. Table of Environmental Specifications

Attribute	Specification
Operating Temperature	5 to 40°C (15 to 30°C is optimal)
Operating Humidity	20 to 80%
Transportation and Storage Temperature	-20 to 60°C
Transportation and Storage Humidity	<60%
Environment	Approved for indoor use
Altitude	Approved for use up to 2000m
Sound Pressure	45-50 db

Pollution Degree	2

Electrical

Table 9. Table of Electrical Specifications

Attribute	Specifications		
	Extrakt 110	Extrakt 110+	Extrakt 140
Full Load Amps	46 FLA	57 FLA	100 FLA
Voltage	240 VAC	240 VAC	240 VAC
Phases	Single phase	Single phase	Three phase
Frequency	60 Hz	60 Hz	60 Hz
SCCR	10 kVA	10 kVA	10 kVA
Enclosure Ingress Protection	NEMA 1, Tools required	NEMA 1, Tools required	NEMA 1, Tools required
Electrical Input Connection	Field wired. 100 Amp dedicated circuit suggested.	Field wired. 100 Amp dedicated circuit suggested.	Field wired. 200 Amp dedicated circuit suggested.
Line Voltages, nominal	Grounded AC	Grounded AC	Grounded AC
Protection class	Class I	Class I	Class I
Overvoltage category	II	II	II
Pollution degree	2	2	2

The 5 HP Durachill Polyscience chiller required for the Extrakt 140 has additional electrical requirements. These are 230V, 3 phase, 60 Hz at 35.2 FLA. Further installation details are found in QP-002 and Polyscience's documentation package.

The size and overcurrent protection of the supply conductors to machine shall be covered by Article 670 of NFPA 70.

Venting

Table 10. Table of Venting Specifications

Attribute	Specifications
On board venting (front)	Manual damper controlled vent for direct exhaust of collection gasses
Extractor Column venting	Venturi damper controlled onboard vent for direct exhaust of extractor gasses
Venting connection	600-2000 cfm vent fan, earth grounded 2" EMP pipe
Anti-Static Piping	Conductive, Antistatic, carbon steel
Grounding	Earth ground required
Wetted Materials	Carbon Steel, Anti Static Poly Propylene
Chemical Compatibility	Gasses, polar solvents, no acids or bases

Process Utilities Requirements Summary

Table 11. Table of Process Utilities Requirements

Process Utilities Requirements				
TYPE	**QUALITY**	**CAPACITY**	**PRESSURE**	**TEMPERATURE**
Compressed Air	Class IV 40 µm filtered, oil free,	0.33 Nm^3/h	80 psi	Room

Solvent	Food grade or better 2 µm Filtered, degassed	36 mL/min max	N/A	5°C to 60°C
Carbon Dioxide, Liquid	2 µm Filtered, 850 psi, food grade or better	300-600 mL/min	850 psi inlet	20-30°C
Chiller Fluid	Clean, 50/50 mix	1 m^3/h max	6 bar max 0,7 bar @ 1 m^3/h	-5°C to 90 °C

Step 1: Assembly of the Terpene Trap

The post collector and terpene collector assemblies are shipped in separate boxes. They must be located and assembled into a unit before the assembly can be installed in the machine. To accomplish this, connect the fluidized bed (1) onto the post collector tank (4) as is illustrated in the following figure:

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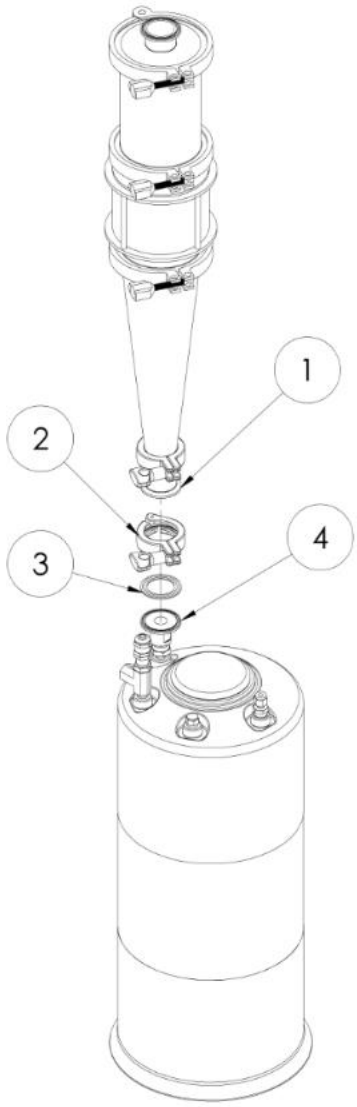

Figure 5. Post collector vapor expansion tank flange (4) connects to the fluidized bed flange (1) with a triclamp sanitary flange (2) and 1-1/2" nitrile gasket (3).

Step 2: Installing the Terpene Trap Assembly into Instrument

The following diagram shows the connections that need to be made to install the terpene trap into the instrument. To install, the post collector (3) must be connected to the post heater (2) using the provided post heater to post collector tubing. Two 9/16" open end wrenches are required to install the connection tubing. One wrench holds the fitting adaptor and the other

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wrench tightens the nut onto the adaptor.

! NOTICE: If you do not use two wrenches, you could potentially cause physical damage to the threads on the post collector (3).

The following diagram shows the tubing connections that need to be made:

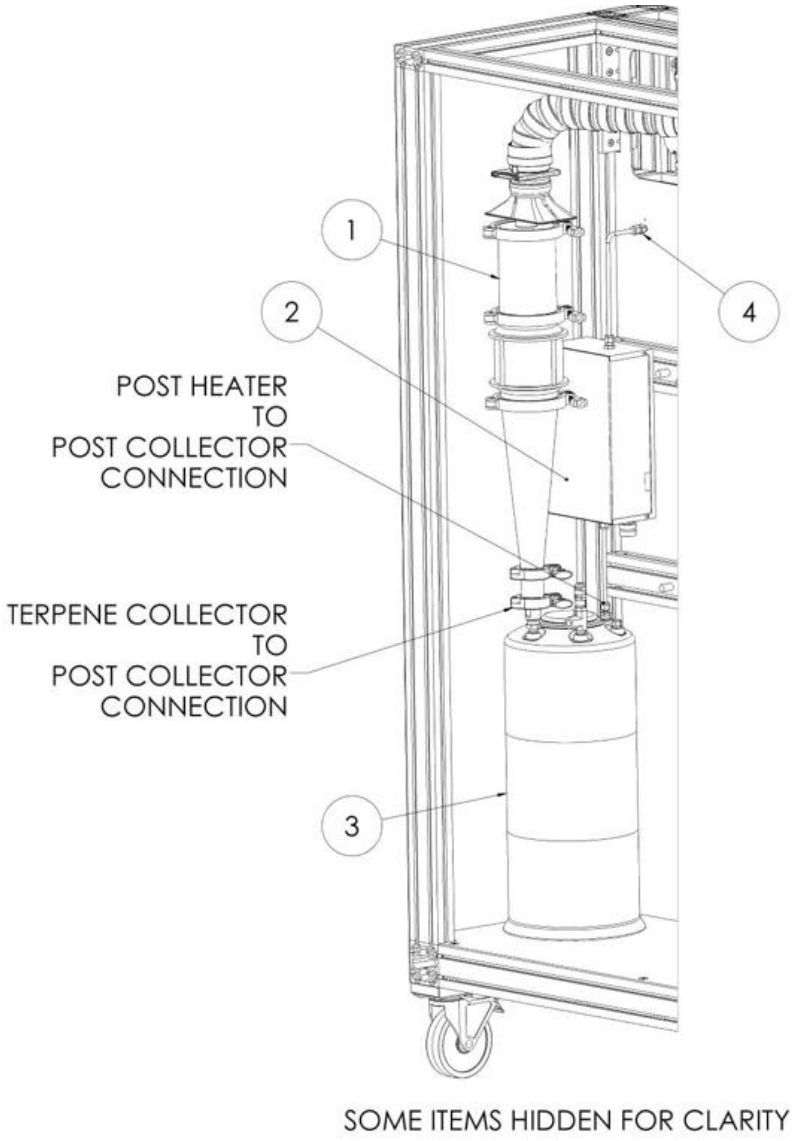

Figure 6. Side view of extractor showing locations for post collector plumbing attachment. (1) Fluidized bed terpene collector*, (2)* Post heater*, (3) Post collector, (4) Bulkhead connector.*

All post heater to post collector connection tubing is pre-cut to length for installation. The tubing is located in the installation start-up kit.

! NOTICE: Follow provided Swagelok instructions for properly tightening Swagelok fittings.

When no post heater is installed, tubing is provided to connect the post collector directly to the bulkhead. The installation procedure remains the same as described above.

Step 3: Installing the Ethanol Pump

Pump Components

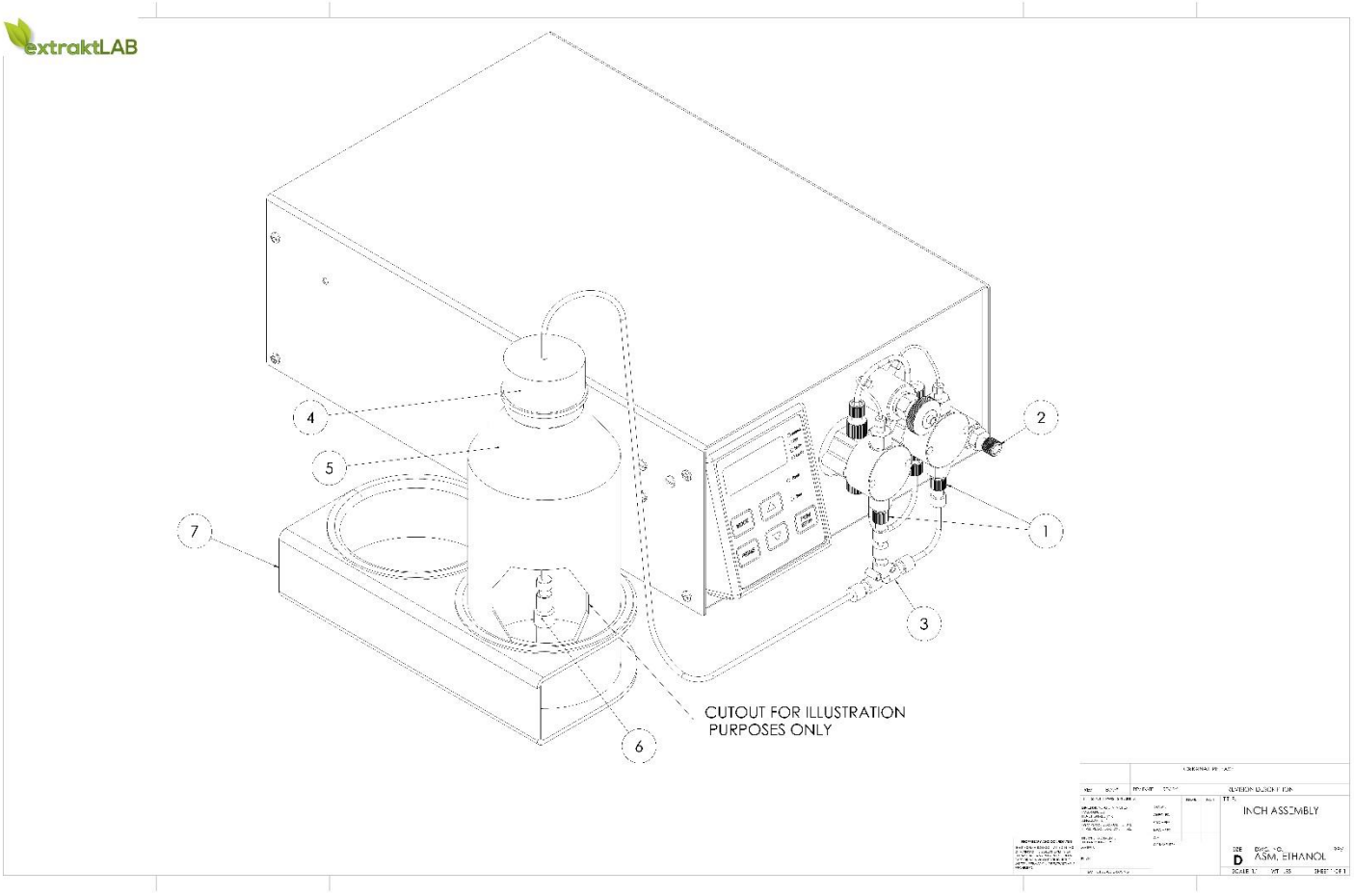

Figure 7. Optional Ethanol Pump

Descriptions of Components

Table 12. Ethanol Pump Components

Items	Location	Description
Inlet	1	Inlet of low pressure ethanol feed
Outlet	2	Outlet of pressurized ethanol
¼-28 PEEK Tee	3	Inlet feed split for pump head 1,2
1 L bottle Cap w/ Hole	4	Cap to prevent ingress of dust.
1L Bottle, glass	5	Ethanol or solvent reservoir.
Inlet filter, 2 um, PTFE	6	Inlet filter for ethanol.
Bottle Holder	7	Holds bottles on the shelf.

The installation kit contains a 2L glass bottle to be used as an ethanol container. The cap has a hole in the top that will accommodate the plastic tubing. First locate the bottle in the start-up kit. Second, unthread the inlet filter so that the 1/8" FEP tubing can be inserted into the hole in the cap. Third, re-thread the inlet filter onto the end of the tubing. Fill the vessel with ethanol. Screw the cap onto the bottle. Place the bottle in the pump

cabinet on the shelf next to the ethanol pump.

Step 4: Installing the Ventilation System

WARNING: Ventilation fans and mechanicals must be installed properly and in accordance with local and national safety standards. The room should be ventilated to maintain the proper air exchange as per engineering specifications and ambient 600-1200 ppm CO_2 air concentration under all operating conditions.

NOTICE: All containers and vent piping must be grounded to earth ground during operation.

WARNING: All required PPE is to be utilized during venting operations to prevent possible injury or frostbite.

NOTICE: All ventilation components must be antistatic and grounded.

NOTICE: Installation of a CO_2 detector in the room is required.

The vent system is comprised of the following components:

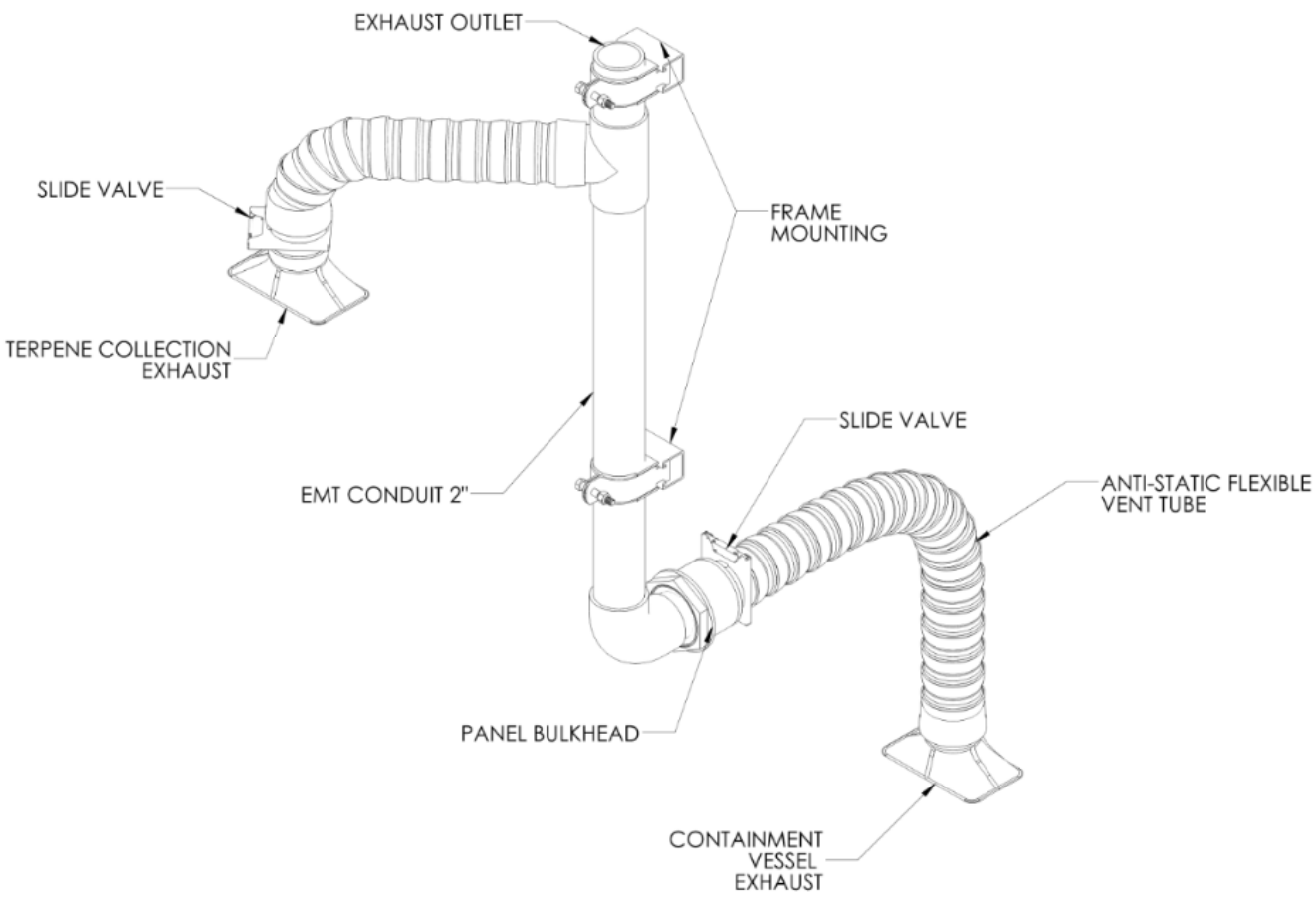

Figure 8. Close up of Rear View detailing venting system including: vent for terpene collection exhaust, slide damper valve, grounded EMT conduit, front anti-static vent tube for interfacing with containment vessel, front slide damper valve for both venturi and containment exhaust, exhaust outlet connection.

To utilize the venting system, a vent fan must be attached to the 2” exhaust outlet connection. It is required that the customer install a vent fan in their facility that conforms to the installation qualification documentation and is compliant with local electrical and safety codes.

Step 5: Installing Extraction Room Sensors

We also recommend the following external sensors and alarms for rooms dedicated to supercritical CO_2 extraction or separation. Alarms include:

- CO_2 sensor and alarm to warn of large leaks or cylinder leaks.

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- Lower explosive limit sensor and alarm to monitor for organic solvents.
- Oxygen sensor with alarms to warn of oxygen depletion.

Step 6: Connecting the System to Electrical Power

WARNING: To avoid electrical shock, always inspect any power cords for damage. Power off and unplug the system before performing maintenance, ensure that the source is properly grounded to earth ground. Use power cord that is approved and sized by a qualified electrician.

!

NOTICE: Electrical installation must conform with the installation requirements as set forth in the Installation Qualification and Operational Qualification documentation provided with the instrument and with local and national electric codes. It is the customer's responsibility to conform to the instrument specifications.

Figure 9. Figure showing the location of the electrical knockout on top of the electrical panel box. The knockout plug can be removed via a wingnut accessed from the inside of the electrical panel box.

Wiring the Extrakt 110 and 110+

The extractor requires 47 (Extrakt 110) and 57 amps (Extrakt 110+) at 120/240 volts (2 separate 120 volt wires are required. No “high/hot/wild” 208 volt wire can be used.) All wires from facility load center to the extractor require a two pole single phase 100 AMP main circuit breaker, and proper wire sizing to the extractor must meet IEC code or most applicable electrical code. 250V 4 wire, separate center lug neutral and ground required on transformer. We recommend that customers run no less than 8 gauge SOOW drop cord wire to connect the extractor main power input location. Customers are responsible to verify correct wire conductors size from facility electrical service to extractor final location. Separate ground and neutral from facility load center is required to extractor electrical load center.

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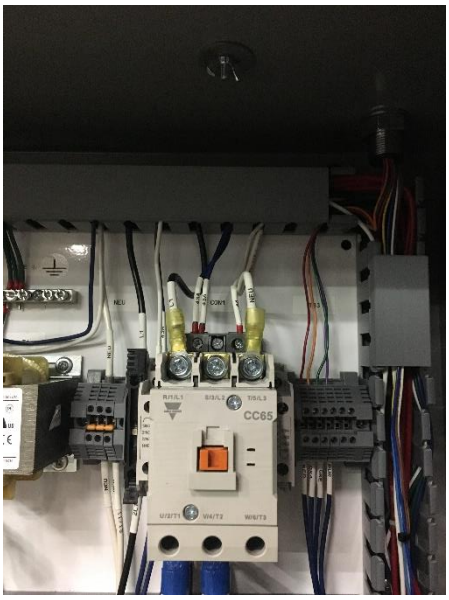

Figure 10. Primary contactor for Extrakt 110 and Extrakt 110+

Wiring the Extrakt 140

Measure each leg of the main power supply voltage at the main power source. Voltage must be within the voltage utilization range given on the drawings included in the unit. If the voltage measured on any leg is not within the specified range, do not power or use the unit. Voltage imbalance must not exceed 1%. Excessive voltage imbalance between the phases of a three phase system can cause motors to overheat and fail. Voltage imbalance is calculated:

% Imbalance = $(V_{ave}-V_x) \times 100 / V_{ave}$
Where V_{ave} is the average voltage from L1,L2, L3 and V_x is the phase with the greatest difference from V_{ave}.

The Extrakt 140, requires 100 full load amps at 120/240 volts three phase, + Neutral & Ground (5 Wire), 60 Hz. All wires from facility load center to the Extractor(s) require a three pole, 3 phase 200 AMP main circuit breaker. Facility owner is responsible to correctly size all electrical conductors to Extractor(s) and required to meet most applicable electrical code(s). Customer may connect the instrument through an appropriate disconnect switch as local codes may require.

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Check the electrical phase sequence at installation prior to start-up. Operation of the compressor with incorrect electrical phase sequencing will result in mechanical damage to the pumps. Check the phasing with a phase sequence meter prior to applying power. The proper sequence should read A-B-C on the meter. If the meter reads C-B-A, open the main power disconnect and switch two line leads on the line power terminal blocks. Do not change any load leads that are from the unit contactor or motor terminals.

Figure 11. Load center for Extrakt 140.

Step 7: Connecting the CO_2 to the System

WARNING: Wear all applicable PPE.

WARNING: To prevent CO_2 tanks from tipping and causing bodily injury, secure tanks to the wall using safety strapping.

WARNING: Use only connection tubing provided in the installation kit. Substitutions may not have the proper pressure rating.

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WARNING: Tubing should not be removed from the system without first shutting off all valves and venting. Failure to turn off CO_2 at the CGA valve can cause the tubing to move uncontrollably and cause bodily harm.

Required Tools

- 9/16” open end wrench
- 1 1/8” open end wrench
- Manifold as provided in CO_2 Connection Kit
- 3/8” open end wrench

Verifications

Verify the CO_2 grade conforms to the desired specifications.
The CO_2 can be connected to the system via a Swagelok fitting that is provided in the CO_2 Connection kit.
The installer will follow the guidelines for making and breaking Swagelok connections that are provided with the instrument.

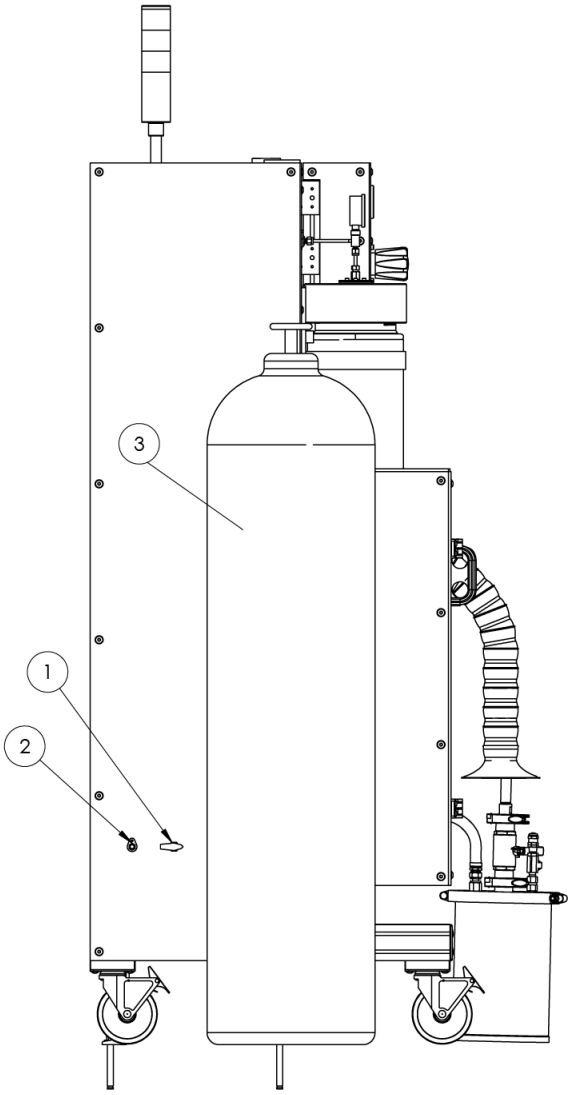

Figure 12. Side view of extractor showing CO_2 cylinder (3), on off valve (1), and inlet bulkhead fitting (2).

Procedure for Cylinder Install

The CO_2 manifold for ganging CO_2 tanks comes pre-assembled.

1. Locate the manifold in the installation kit.
2. Locate the CGA fitting connected to the manifold and thread the CGA fitting onto each of the six CO_2 cylinders. Verify that the nylon washer that interfaces between the CGA fitting and the cylinder male thread is present.
3. Tighten the CGA fitting with the provided 1 1/8” open end wrench.

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4. Locate the end of the manifold that has the ¼" Swagelok fitting (Extrakt 110 and Extrakt 110+) or 3/8" Swagelok fitting (Extrakt 140) installed.
5. Screw the Swagelok fitting onto the inlet Swagelok bulkhead.
6. Tighten the fitting finger tight plus ¼ turn.
7. Ensure the inlet ball valve is turned off.
8. Turn on each of the 6 CO_2 cylinders.
   CO_2 is now plumbed and supplied to the instrument.

Step 8: Connecting the System to Bulk CO_2 Tank

If you are connecting the system to an in house CO_2 supply, keep in mind that the minimum inlet pressure must be 750 at 25°C. This application may require a recirculation pump or fill pump to provide the inlet pressure required. At a minimum, a back pressure regulator is required to keep the inlet pressure at or around 800 psi.

Step 9: Connecting the System to Compressed Gas

A compressed gas connection (2) is provided and is located on the top of the pneumatics panel (1). A female US compressed gas connector ColorConnex Push-To-Connect female Green Coupler, ARO Type B 1/4 in. FNPT will provide clean dry compressed (85 psi) air to the instrument. Refer to the installation qualification documents for specifications on air quality and level. Poor air quality (water and oil) will cause premature failure of the air control system. Valve failure may result when air quality is non-conforming.

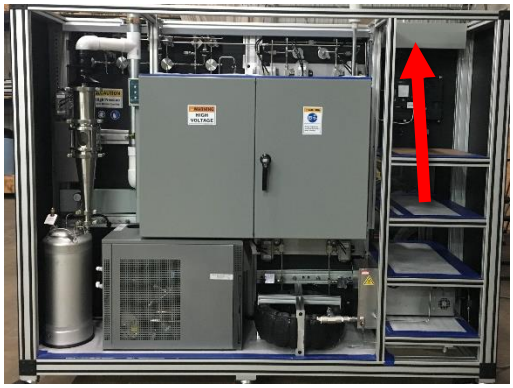

Figure 13. Installation details showing location of compressed gas connection in pneumatics box.

Step 10: Connecting the System to WIFI

If the customer desires remote technical support, software updates, or IPAD access, connect your computer and wireless access point to the Ethernet port. The following figure shows the capabilities that WIFI access brings to your machine.

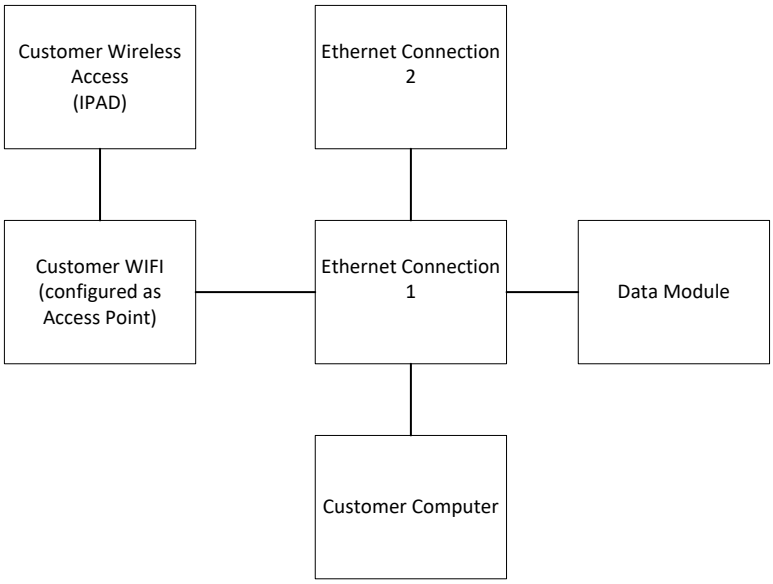

Figure 14. Chart showing the capabilities that WIFI access brings to the machine.

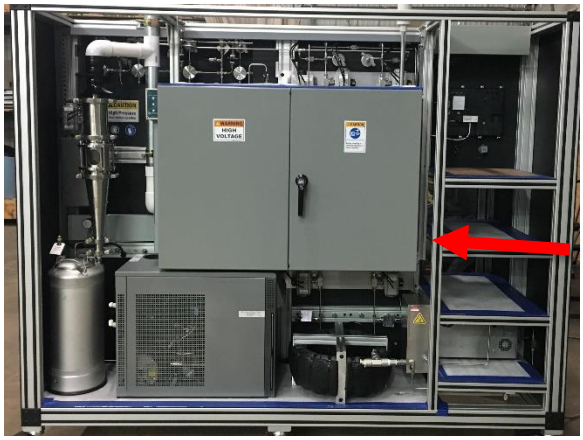

Figure 15. Figure showing the location of the ethernet port on the side of the electrical panel box.

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An ethernet port are located on the side of the electrical panel box.

- To connect your computer, obtain an Ethernet cable and plug it in to the supplied port. Locate the Ethernet to USB adapter supplied in the installation start-up kit. Plug the Ethernet cable into the Ethernet adaptor and the USB into the computer.

- To connect your wireless access point, obtain an access point and configure it as a bridge for your network and for the instrument network. Information you will need:

  Input IP address 192.158.2.150 for Instrument Network

Setting up your IPAD

Once your computer is configured as a bridge, download the Cmore HMI app from the Apple or Droid App Store. Input IP address 192.158.2.150 into the connection option and press connect.

Obtaining Data from Your Instrument

Run time, method, event data, method meta data, and sequence data can all be obtained from the system.

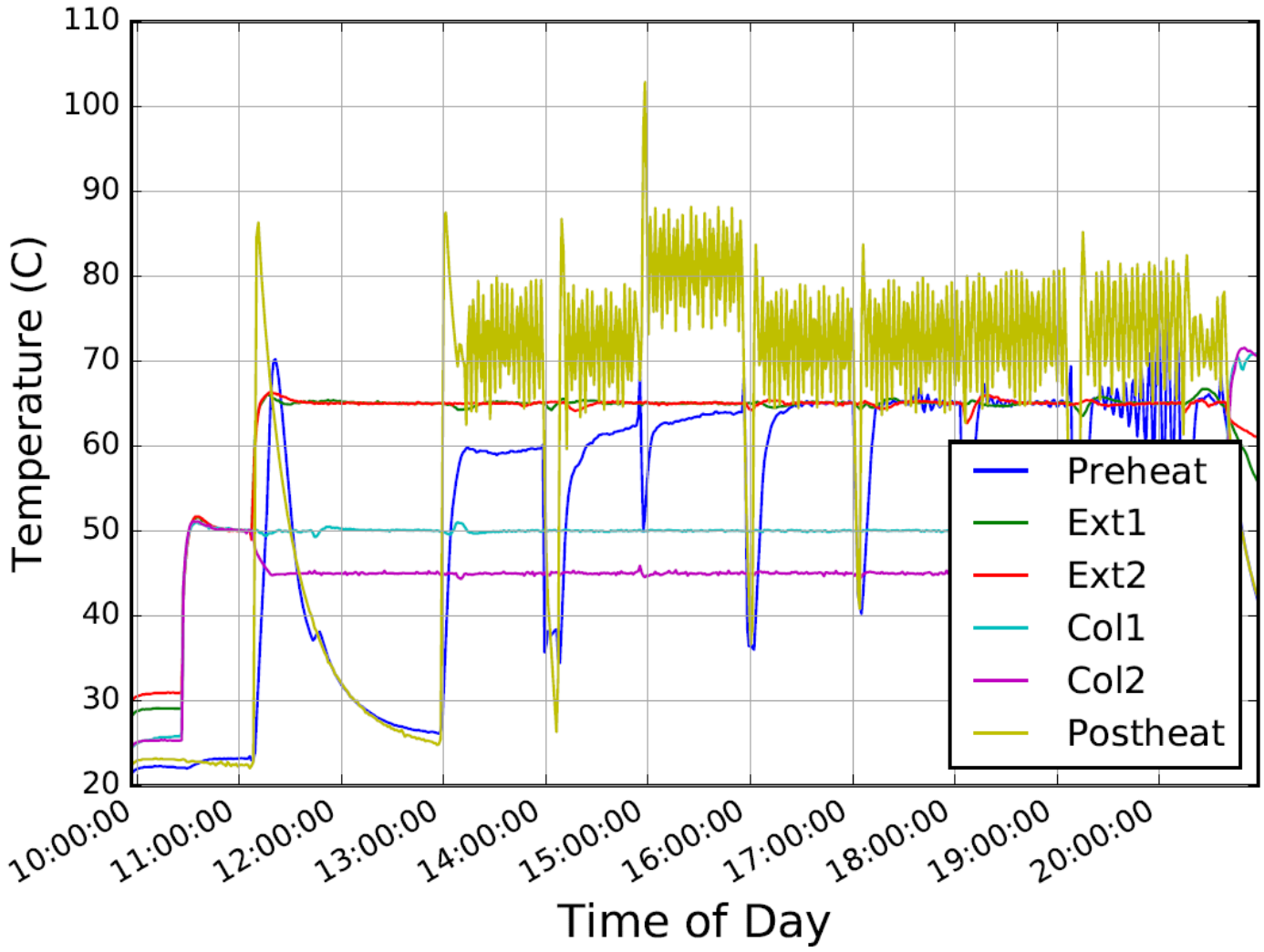

Figure 16. Figure showing an example of data, including run time, method, event data, method meta data, and sequence data that can be obtained from the instrument.

Remote Technical Access

For remote technical access, download the logmein client at www.logmein.com and contact technical support for further instructions.

Step 11. Fill out QP-001 Site Compliancy Documentation

- Locate the site check off list QP-001 in CP-019 Site Acceptance Test Plan (Extrakt 110

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and 110+) or QP-002 in CP-022 Site Acceptance Test Plan (Extrakt 140).

- Fill out the compliancy document fully. If there are any variances, note them on the documentation.
- Obtain the proper signatures from your qualified electrical, HVAC, and operations management.
- Send completed documentation to United Science to obtain warranty coverage.

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Normal Operation

Startup

The purpose of this section is to provide a description of the operations of United Science Supercritical CO_2 Extractors. The following topics will be covered in this document:

- Establishing, setting and maintaining CO_2 flows
- Operating Pumps
- Setting and monitoring temperatures for the preheater, extractors and collectors in the system compensating for axial gradients
- Establishing and correcting set points for the BPR (Back Pressure Regulators)
- Loading and unloading the extractor with sample material
- Swagelok fittings: tightening and loosening connections WI-006
- Performing an extraction
- Creating and running methods
- Pressure transfer procedure
- Collecting
- Terpene collection system: maintaining, collecting and regenerating
- Instrument cleaning
- Cleaning run
- Routine maintenance
- Troubleshooting

Turning on the Instrument

Locate the on off switch located on the front panel under the HMI panel. Refer to the Front View in the Components section for correct location. Note that the Estop button must be released in order for the system to turn on. Once the system has been turned on, the HMI panel will signal that the firmware is loading.

Turning on the Chiller

WARNING: Do not operate the chiller without coolant.

WARNING: Ethylene glycol is toxic and can cause death if ingested. Propylene glycol/water mixtures are preferred.

! NOTICE: Glycol based coolants are flammable at very high temperature.

! NOTICE: User shall be familiar with safety and hazard warnings that are detailed in the chiller manufacturers manual.

The chiller for the system is set at the factory to 2ºC and is filled with 50/50 mixture of propylene glycol water.

Check the level of fluid before operating. Refer to chiller operator manual for instructions for checking the level of fluid and conformance to safety requirements.

The chiller for the recycler system is set at the factory to -5ºC and is filled with 50/50 mixture of propylene glycol water. The temperature measured at the heat exchanger and reported on the HMT panel approximates the temperature of the fluid entering the recycler.

Touchscreen Operation

The Extractor is operated via the touchscreen interface located in the upper left hand corner of the instrument, above the pump cabinet. The panel is a visual representation of all of the control surfaces that can be monitored and changed by a simple touch.

The following items can be controlled from the touchscreen.

- Heater Temperature Set point
  - Preheater: Heats the CO_2 entering the extractor column
  - Extractor Column Heaters: Heats the product during extraction
  - Collector Heaters: Heats the Collector vessels
  - Post Collector Heater: Optional heater aid in venting outgoing CO_2
- Pneumatic Valves controlling the flow path of CO_2
- CO_2 Pump Control
- Ethanol Pump Control
- Manual Run Control
- Method Editor
- Sequence Editor
- Chiller control
- Recycler Run Control

Human Machine Interface Familiarization – Extrakt 110 and Extrakt 110+

The following diagram shows operator controls for manipulating and programming the fluid flow through the instrument.

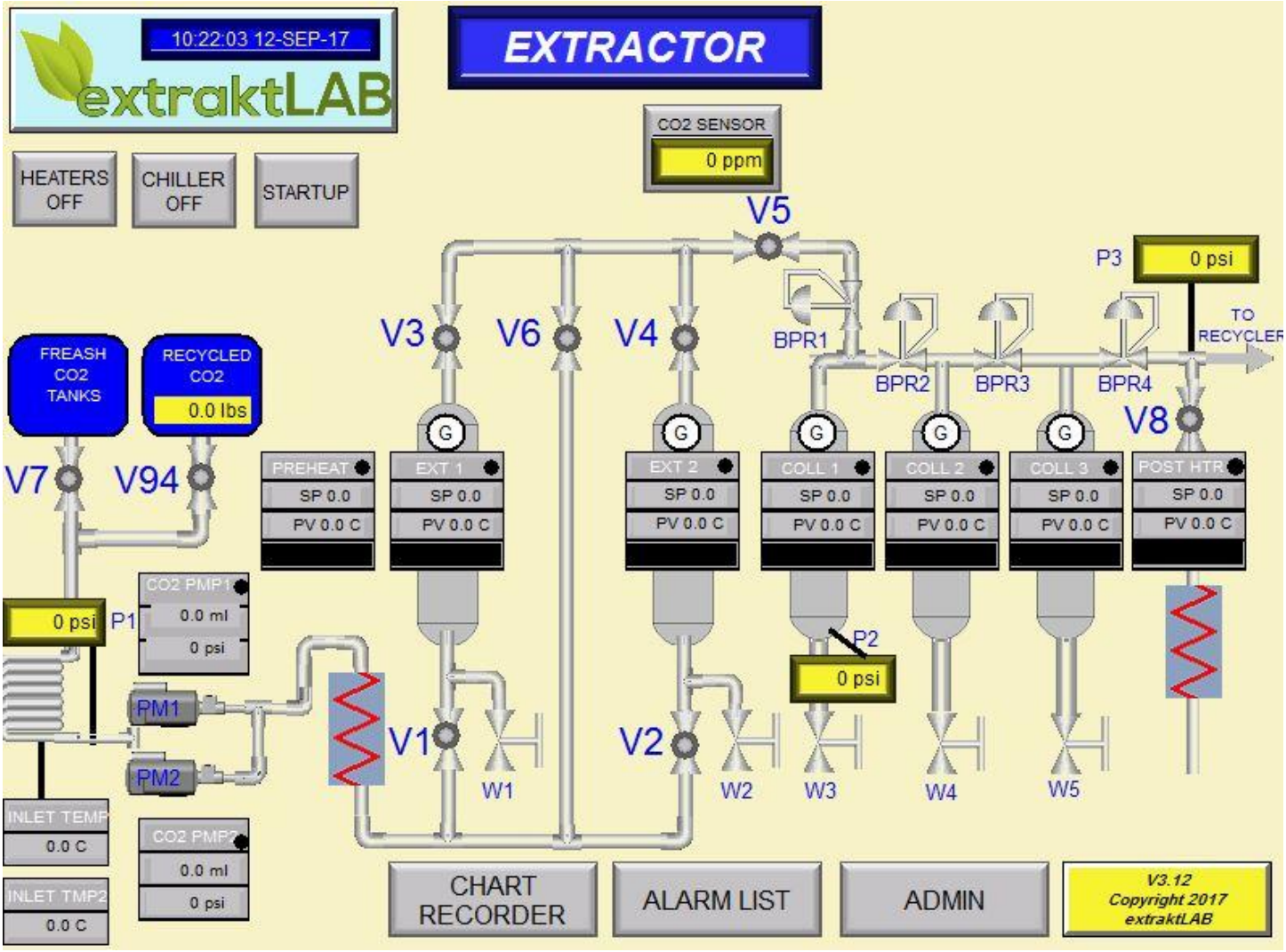

Figure 17. HMI control panel

Table 13. HMI Label Description

HMI Label	Description
Heaters Off	Turns heaters on or off.
Pump Off	Turns CO_2 pumps on or off. Also functions as a method pause.
Chiller Off	Turns chiller on or off.
Start Run	Starts a run from a selected sequence or method.
Method Editor	Edits methods and sequences.
P1	Pump inlet pressure transducer
PM1	CO_2 Pump 1
PM2	CO_2 Pump 2
Inlet Temp	Temperature of CO2 at heat exchanger
Inlet Temp 2	Temperature at Pump Inlet
CO2PMP1	On/Off indicator, flow rate indicator, pump pressure indicator (psi)
CO2PMP2	On/Off indicator, flow rate indicator, pump pressure indicator (psi)
PREHEAT	Preheater for CO_2 fluid entering extractors
V1	Inlet valve for Extractor 1
VV1	Vent valve for Extractor 1, manual
V2	Inlet valve for Extractor 2
VV2	Vent valve for Extractor 2
V3	Exit valve for Extractor 1
V4	Exit valve for Extractor 2
V6	Transfer valve, manual
V5	Extractor isolation valve
V7	Inlet valve for fresh CO_2
V8	Outlet valve for flow path to atmosphere
V94	Inlet valve for recycled CO_2
P2	Pressure transducer for collector 1
BPR2	Sets pressure for collector 1.
BPR3	Sets pressure for collector 2.

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BPR4	Sets pressure for collector 3.
P3	Pressure transducer for system exit
EtOH PMP	Pump for ethanol
VV3	Vent valve for collector 1, manual
VV4	Vent valve for collector 2, manual
VV5	Vent valve for collector 3, manual
POST HTR	Post heater for heating effluent
COMPLETE%	Display of % of run complete including steps remaining
Current Method	Display of current run method
CO2 PPM	System CO_2 monitor
PV	Present value of the thermocouple
SP	Set-point of the heater
Chart Recorder	Chart recorder for temperature, flow rate, and pressure recording
Alarm List	Log of recent alarms
Admin	Sub menu for administrative settings

Human Machine Interface Familiarization – Extrakt 140

The following diagram shows operator controls for manipulating and programming the fluid flow through the instrument.

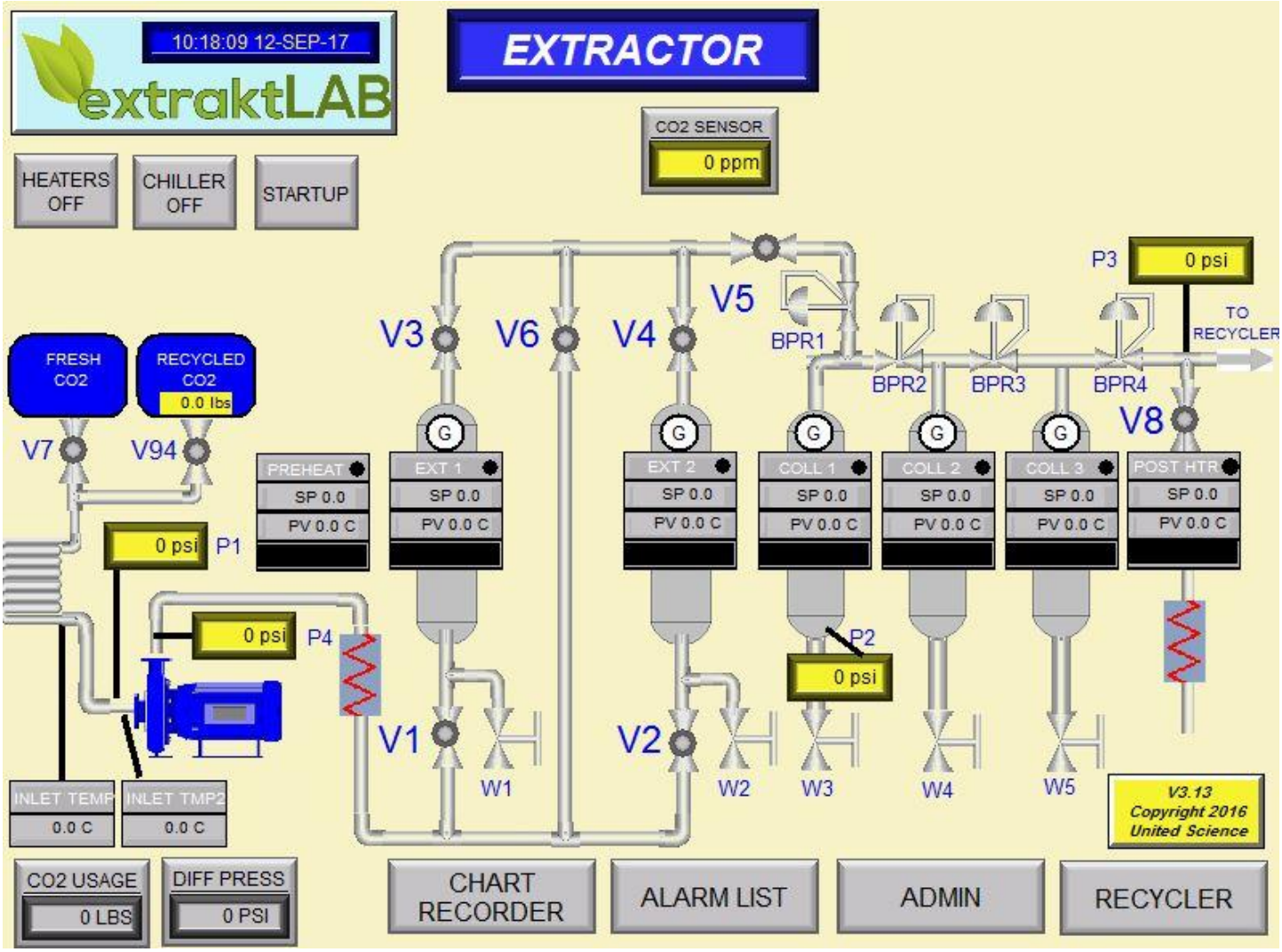

Figure 18. HMI control panel

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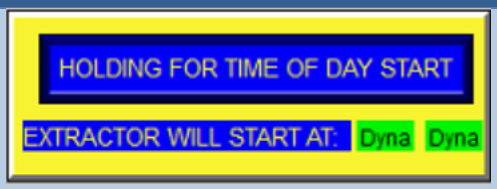
Table 14. HMI Label Description

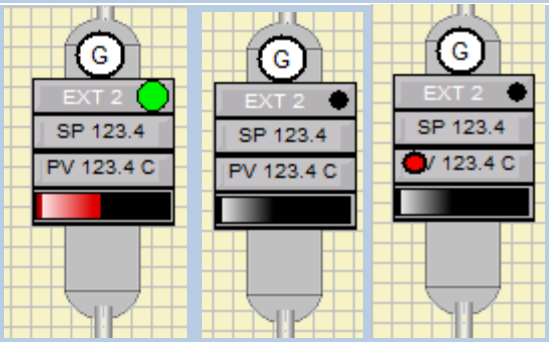
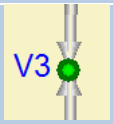
HMI Label	Description
Heaters Off	Turns heaters on or off.
Pump Off	Turns CO_2 pumps on or off. Also functions as a method pause.
Chiller Off	Turns chiller on or off.
Start Run	Starts a run from a selected sequence or method.
Method Editor	Edits methods and sequences.
P1	Pump inlet pressure transducer
P4	Pump outlet pressure transducer
PM1	CO_2 Pump 1
Inlet Temp	Temperature of CO2 at heat exchanger
Inlet Temp 2	Temperature at Pump Inlet
PREHEAT	Preheater for CO_2 fluid entering extractors
V1	Inlet valve for Extractor 1
VV1	Vent valve for Extractor 1, manual
V2	Inlet valve for Extractor 2
VV2	Vent valve for Extractor 2
V3	Exit valve for Extractor 1
V4	Exit valve for Extractor 2
V6	Transfer valve, manual
V5	Extractor isolation valve
V7	Inlet valve for fresh CO_2
V8	Outlet valve for flow path to atmosphere
V94	Inlet valve for recycled CO_2
P2	Pressure transducer for collector 1

BPR2	Sets pressure for collector 1.
BPR3	Sets pressure for collector 2.
BPR4	Sets pressure for collector 3.
P3	Pressure transducer for system exit
EtOH PMP	Pump for ethanol
VV3	Vent valve for collector 1, manual
VV4	Vent valve for collector 2, manual
VV5	Vent valve for collector 3, manual
POST HTR	Post heater for heating effluent
COMPLETE%	Display of % of run complete including steps remaining
Current Method	Display of current run method
CO2 PPM	System CO_2 monitor
PV	Present value of the thermocouple
SP	Set-point of the heater
Chart Recorder	Chart recorder for temperature, flow rate, and pressure recording
Alarm List	Log of recent alarms
Admin	Sub menu for administrative settings
Recycler	Link to Recycler HMI

Other Notifications and Options

Table 15. HMI Notification Table

Icon	Description
	This icon will show when time of day sequence option is selected.
	This icon will show when the extractor is running a method or sequence and used to

	abort the run.
	This icon shows that a run is complete.
	This icon will show when the method is paused or is holding for a time of day start. See sequence options.
	Heaters are labeled and display two values, PV and SP. PV is the present value and is the thermocouple reading. SP is the set point temperature. If the heater is being powered there will be a green indicator light next to the heater name. The red bar indicates the level of power delivered to the heater. If the heater is not being powered, the red bar will turn black and the on/off indicator will also be black. If there is a heater fault, a red dot will appear and the heater will shut off.
	The pneumatic valves are either on or off. Users can tell if a valve is open when there is a green indicator light in the circle next to the valve number.
	Alarm for high inlet CO2 temperature. To clear this alarm, check the chiller. Restart the pump once temperature has decreased below 10oC.

	Alarm for high pump pressure. To clear this alarm, it is necessary to troubleshoot the cause of the alarm. Check BPR1, V5 and check valve. To reset the alarm, restart the pump.
	Alarm for high pressure in collector 1. Check BPR2.
	Alarm for CO2 outage. Change tanks so that pressure increases to 750 psi.
	Alarm for high CO2 above 9000 ppm. Indicates a major leak. Will shut down pumps and valves. To reset, the room must clear of elevated CO2.
	Warning Light for high CO2 above 5000 ppm.

Chart Recorder

The system is equipped with a chart recorder so that historical data may be reviewed. Data recorded include:

- Extractor Temperature
- Extractor Pressure
- Collector Pressure
- Exit Pressure
- Recycler Pressure
- CO_2 Level
- Inlet Temperature and Pressure

To review the chart recorder data, press the chart recorder button on the main panel.

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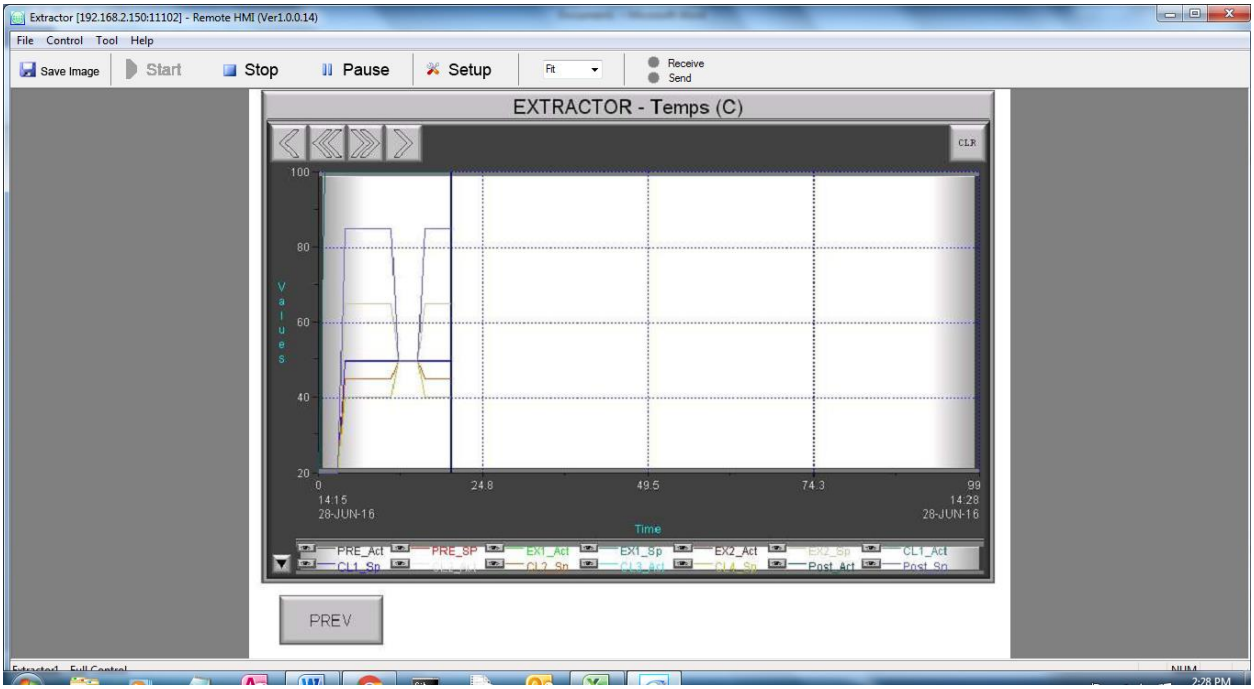


Figure 19. Example of extractor data collected.

Pressure, temperature, and CO_2 traces can be viewed or turned off by pressing the PREV button. The following table defines the plot lines:

Table 16. Chart Recorder Parameters

Parameter	Description
CO2_PPM	CO_2 meter output, ppm CO_2
Pump1_PSI	Pump pressure, CO_2
Pump2_PSI	Pump pressure, CO_2
Pump3_PSI	Pump pressure, EtOH
Press1_PSI	Inlet CO_2 Pressure
Press2_PSI	Collector Pressure
Press3_PSI	Exit Collector Pressure
Out1_%	Power percent, Preheater
Out2_%	Power percent, extractor 1
Out3_%	Power percent, extractor 2

Out4_%	Power percent, collector 1
Out5_%	Power percent, collector 2
Out6_%	Power percent, collector 3
Out7_%	Power percent, post collector
Inlet_Act	Inlet, actual, ºC
Pre_Act	Preheater, actual, ºC
Pre-SP	Preheater, setpoint, ºC
CL1_Act	Collector 1 actual, ºC
CL1_SP	Collector 1 setpoint, ºC
CL2_Act	Collector 2 actual, ºC
CL2_SP	Collector 2 setpoint, ºC
CL3_Act	Collector 3 actual, ºC
CL3_SP	Collector 3 setpoint, ºC
EX1_Act	Extractor 1 actual, ºC
EX1_SP	Extractor 1 setpoint, ºC
EX2_Act	Extractor 2 actual, ºC
EX2_SP	Extractor 2 setpoint, ºC

Pump Operation

There are 3 different styles of pumps used in the extractor. The CO_2 pump controls the flow of the liquid CO_2 and the prep pump is used to pump ethanol (EtOH) for cleaning or as a process aid.

CO_2 Pump Components (Extrakt 110 and Extrakt 110+)

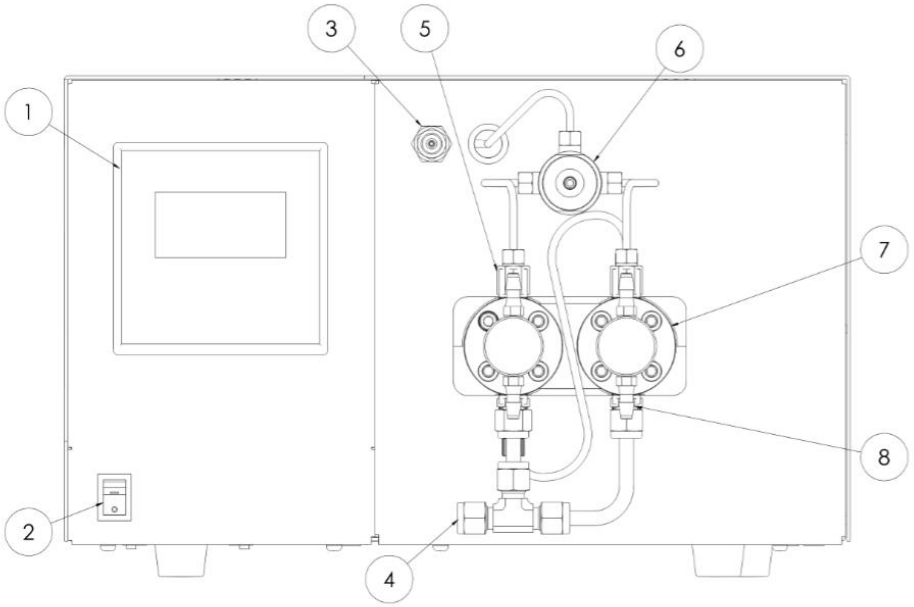


Figure 20. CO_2 pump components.

Table 17. Component Description for Figure 20

Items	Location	Description
Local Pump Control Panel	1	Local pump input
On/OFF	2	On off switch enables power cut off.
Outlet Filter	3	Location of outlet tubing and outlet filter

United Science Corporation
931 Pine Street
Saint Croix Falls, WI 54024-9006

Inlet	4	Location of CO2 inlet.
Outlet Check Valve	5	Location of outlet check valves to prevent backflow into pump.
Black Vent Valve	6	Vent location for removing vapor from pump heads
Pump Head	7	Pump head comprised of a piston
Inlet Check Valve	8	Inlet check valve prevents backflow to exchanger.

CO_2 Pump Components (Extrakt 140)

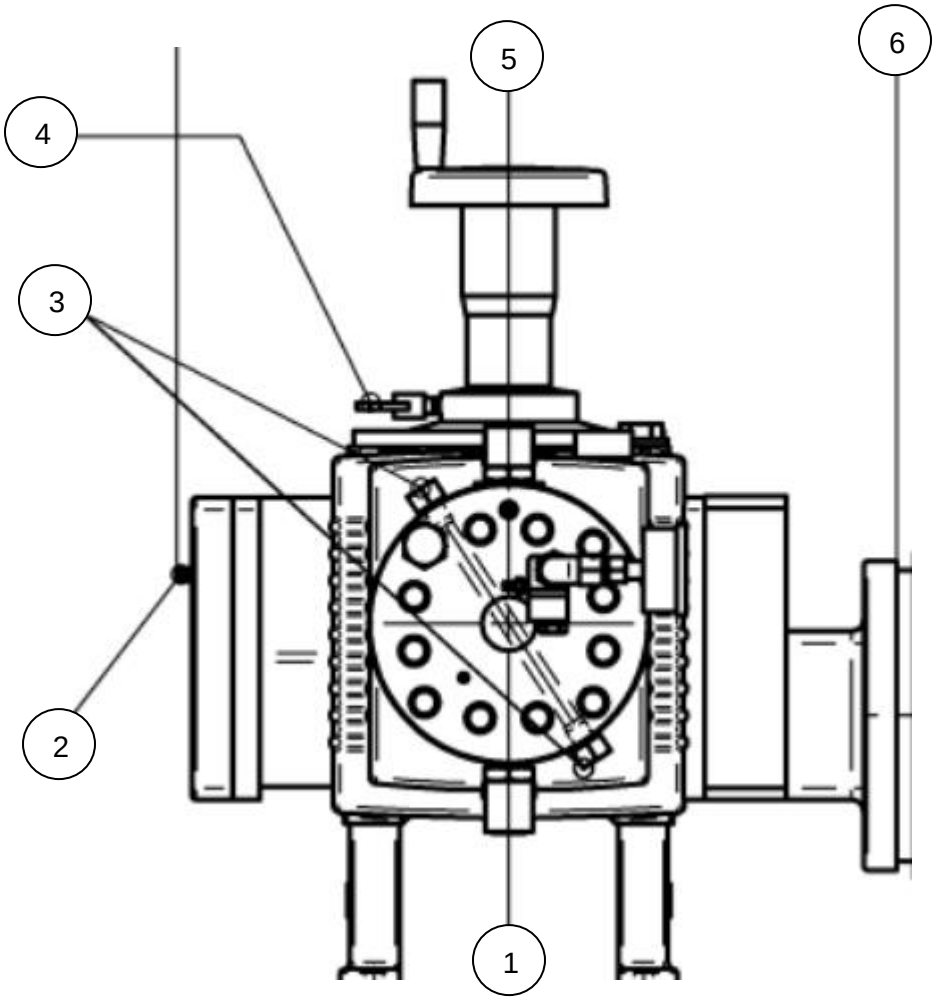


Figure 21. CO_2 pump components.

Table 18. Component Description for Figure 21

Items	Location	Description
Inlet	1	Location of CO2 inlet.
Grounding Connection	2	Pump is grounded to frame through mounting structure.
Chiller Ports	3	Coolant ports for chilling pump head.
Hand Lock	4	Hand lock for stroke length adjustment.
Stroke Length Adjustment	5	Used for adjusting stroke length.
Motor	6	Connection to pump motor.

Ethanol (Solvent) Pump Components

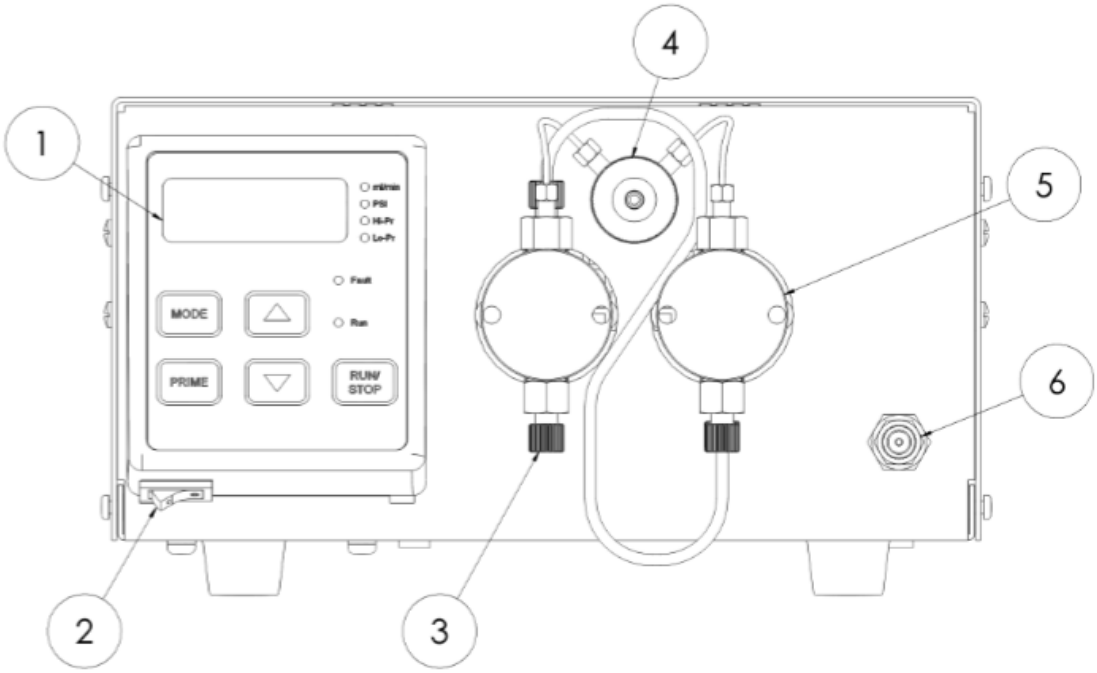


Figure 22. Ethanol pump components.

Table 19. Element Description for Figure 22

Items	Location	Description
Local Pump Control Panel	1	Local pump input
On/OFF	2	On off switch enables power cut off.

Solvent Inlet	3	Location of inlet tubing, 1/8" OD FEP tubing, Flangeless ¼-28 finger tight fitting.
Black Vent Valve	4	Vent location for removing vapor from pump heads
Pump Head	7	Pump head comprised of a piston
Solvent Outlet	6	Solvent outlet.

CO_2 Pump Operation

Turning on the CO_2

In order to start the pump, you must first turn on the manual CO_2 valve located on the side of the instrument as shown in the components section of this manual. The CO_2 cylinder valves must be open in order for CO_2 to flow.

Turning on the Chiller

In order to start the pump, you must first turn on chiller and the inlet temperature must be less than 10°C as read from the inlet temperature readout on the HMI panel. The pump will not turn on unless the chiller is turned on. A warning will show on screen if the chiller has not reached temperature within 10 minutes of turning on the chiller.

Checking CO_2 Pressure

Once the manual valve is open, P1 should read a pressure greater than 750 psi. If it does not, the tanks are either empty or they are cold (T<20°C). You must either let the tanks equilibrate to room temperature or add a blanket heater to the tanks.

Checking the Air Exchange Rate in the Extractor Room

WARNING: To avoid bodily injury, wear protective gloves while performing this operation.

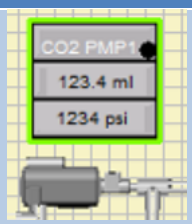
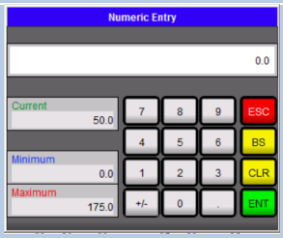
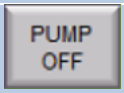
NOTICE: To avoid asphyxiation risk, a calibrated and tested CO_2 meter must be installed if the customer in the room that the instrument is used.

Open the black vent valve located on the pump (Extrakt 110 and Extrakt 110+) or just below the pump inlet (Extrakt 140) by turning clockwise for 30 s to allow CO_2 to flow into the room. If the room is under 1000 ft^2, only allow the vent to vent for 10 s. CO_2 will vent into the room

during this operation and you will see an increase in the ambient CO_2 concentration in the room from 600-800 ppm to 1000-2000 ppm. If the room is properly vented, the CO_2 will dissipate in 5-10 min. If the room is not ventilate properly, consult with your facilities manager to increase the air exchange rate in the room. Guidance is 8-10 exchanges per hour.

Turning on the Pump

Table 20. Steps to Turn on the Pump (Extrakt 110 and Extrakt 110+)

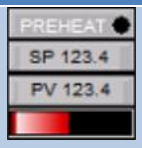
Step	Press	Description
1		Press the CO_2 pump icon to display the flow rate selector.
2		Press in the desired flow rate. If your system is equipped with more than one pump, repeat for the second pump. Icon on pump will turn from black to green to show that the pump is on and flowing.
3		Press pump off button to turn the pump on. Once the flow rate is set, turn off immediately until flow path and BPRs are established.

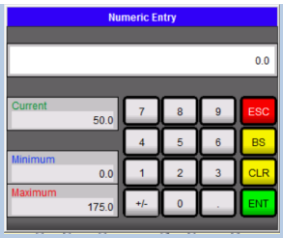
Note: The Extrakt 140 comes with a factory set flow rate and does not require adjustment.

Setting the Preheater Temperature

The preheater will not turn on until the pump is turned on. Follow these steps to set the preheater temperature.

Table 21. Steps to Set the Preheater Temperature

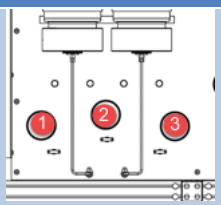
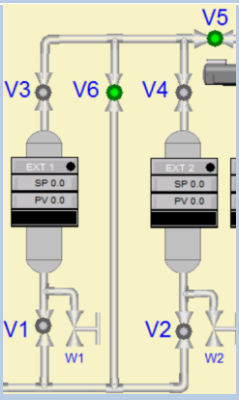
Step	Press	Description
1		Press preheater icon.

2		Set the temperature. Initial value is 50°C. Any temperature under 90°C may be used however. Press ENT.

Establishing an Initial Flow Path for the Purpose of Setting the Back Pressure Regulators

It is recommended that upon startup, the system be brought to pressure without filling the extractors so that the backpressure regulators can be set. To accomplish this, establish the following flow path.

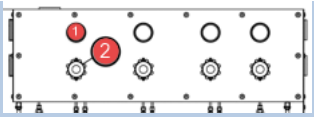
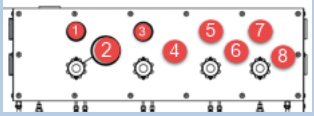
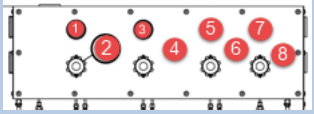
Table 22. Steps to Establish an Initial Flow Path

Step	Press	Description
1		Locate manual transfer valve 2. Open transfer valve. Vent valves 1 and 3 are not transfer valves.
2		Modify flow path according to the figure. Your screen should look like this.
	GO to SETTING THE BACKPRESSURE REGULATORS NEXT	Go to next step.

Setting the Backpressure Regulators

Once the flow is turned on, immediately you will see the gauge 1 pressure increase. Follow instructions in previous section for setting the first back pressure regulator.

Table 23. Steps to Set the Backpressure Regulators

Step	Press	Description
1		Turn on pump by pressing the pump off.
2		Watch pressure gage 1 increase. Turn the pressure regulator 2 clockwise approximately 6 turns and watch gage 1 increase. Dial back counterclockwise as the gauge approaches 5000 psi. ! NOTICE: If you do not dial back the backpressure regulator, the pressure will climb to 5800 psi and the pump will turn off. If this happens, dial back the pressure gauge and restart the pump.
3		Once 1 reaches 5000 psi, gage 3 will begin to climb. Adjust knob 4 clockwise 3-5 turns. Pressure will increase to ~2500 psi. Adjust the knob clockwise/counterclockwise until the gauge reads 2500 psi.
4		Repeat steps for gages 5, and 7 by adjusting knobs 6 and 8 respectively. Adjust pressures to 1250 and 800 psi respectively.

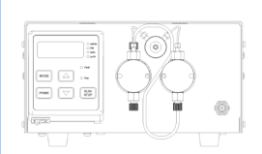
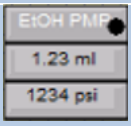
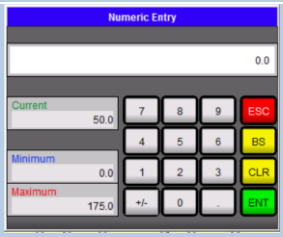
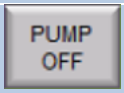
Turning on the Ethanol Pump

! NOTICE: Use proper PPE when handling solvents.

The first step for using the ethanol pump is to fill the ethanol reservoir with 200 proof food grade ethanol. The pump can be set to flow rates between 0.00 and 36.00 mL/min. The ethanol pump draws solvent through the attached 1/8” FEP solvent line. Solvents should be food grade and filtered to 0.45 µm. The flow rate of the ethanol pump is entered in the same

manner as the CO_2 pump. The following lists the steps for pump operation:

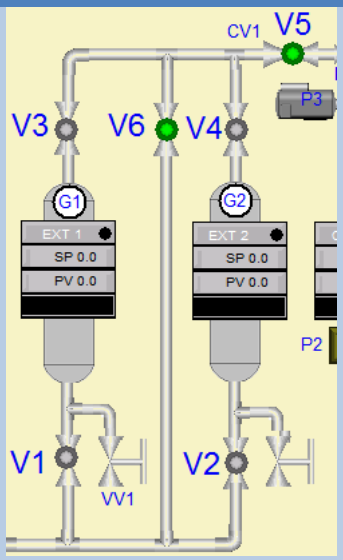
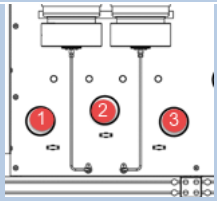
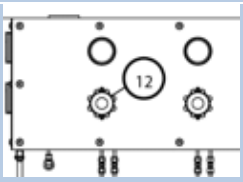
Table 24. Steps to Turn on the Ethanol Pump

Step	Press	Description
1		Prime the pump with the provided syringe. Place syringe into black vent valve located on the front pump. Turn valve counterclockwise to open. Pull syringe to draw ethanol through pump head. You may have to draw several times to remove the air. Bubbles will exit first, then a steady stream of ethanol will exit. Once a bubble free stream of ethanol is established, close black valve. Discard ethanol in a properly labeled waste container.
2		Press ethanol pump icon.
3		Set flow rate from 0-36 ml/min and press ENT. Icon will turn from black to green to show that the pump is on and flowing.
4		Press pump off button to turn the pump on if the pump is not already on. You will see the pump flow rate on the physical pump change from 0 to your set point.

Priming the CO_2 Pump

The most common way to prime the CO_2 pump is to close all valves V1, V2, V3, V4 and open V5 and the manual transfer valve. If possible, make sure that the pump pressure does not read over 800 psi. Turn on the pump and allow the pump to pump up to the pressure set by the first back pressure regulator. Pressure will build very quickly in this case and you should observe the first pressure gauge needle fluctuate. This indicates flow. The following table outlines the steps just described.

Table 25. Steps to Prime the CO_2 Pump

Step	Press	Description
1		Turn off V1-V4. Open V5. Open V6, manual valve.
2		Located V6 valve shown as (2) in the adjacent figure. It is the transfer valve.
3		Turn on pump by pressing the pump off
4		Observe pressure increase to set point of first back pressure regulator. This will happen in 1-2 minutes. Gauge will bounce at the pressure max by +/- 100 psi indicating pressure pulses from pump flow.

Back Pressure Regulators

Technical Description

The CO_2 that travels though the instrument arrives at the pump at ~850 psi and is pumped through the system where it encounters 4 BPR (Back Pressure Regulators). Each of the back pressure regulators can be tuned to provide efficient extraction and precipitation of that fraction into collectors that are held at lower pressures and temperatures.

Supercritical CO_2 extraction of oils from plant matter is based on the solubility of the oils in liquid CO_2. In general, at higher temperature and pressure, the solubility of the oils in the CO_2 is increased. The set points of the back pressure regulators can be modified by the user to optimize precipitation of the extract in each of the three collectors.

The set points are monitored on the display above each BPR. BPRs work like a dam. They hold any pressure in front of it that does not exceed the set point and allow any pressure over the set point to pass through it. No flow is allowed until the BPR set point is reached. Factory set values for the BPRs are as follows.

Table 26. Factory Set Values for the BPRs.

Regulator	Pressure
Extractor	5000 psi
Collector 1	2500 psi
Collector 2	1250 psi
Collector 3	800 psi

Once the pump flow has been established, the pressure will start accumulating in the extraction vessel. The pressure of the extraction vessel is controlled from the first BPR on the gauge panel labeled Extractor. Users can tell when a BPR set point has been reached when pressure has begun to build at the following BPR. If the pressure needs adjusting, simply dial the pressure up or down accordingly. The pressure is increased by turning the dial to the right(clockwise). The pressure is decreased by turning the dial to the left(counter-clockwise). The pressure should be adjusted up or down gradually as there is a several second delay between making an adjustment and the system to register the change.

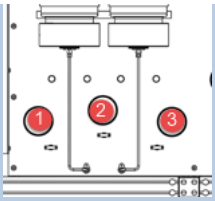
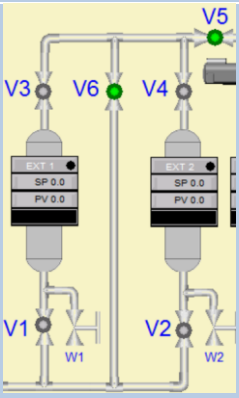
If the pressure set points of the BPR have not previously been set, follow these guidelines.

Setting Back Pressure Regulators

The first step is to establish a flow path:

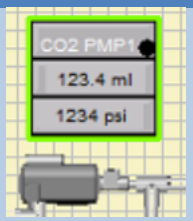
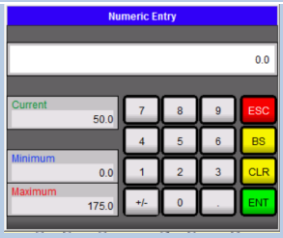
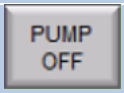
Table 27. Steps to Establish a Flow Path

Step	Press	Description

1		Locate manual transfer valve 2. Open transfer valve. Vent valves 1 and 3 are not transfer valves.
2		Modify flow path according to the figure. Your screen should look like this.

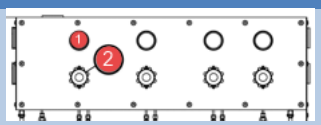
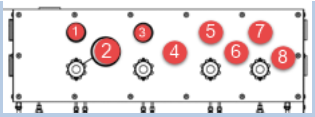
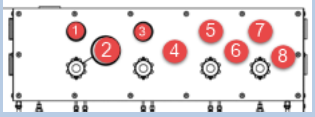
Then turn on the pump:

Table 28. Steps to Turn on the Pump

Step	Press	Description
1		Press the CO_2 pump icon to display the flow rate selector.
2		Press in the desired flow rate. If your system is equipped with more than one pump, repeat for the second pump. Icon on pump will turn from black to green to show that the pump is on and flowing. (Extrakt 110 and Extrakt 110+ only)
3		Press pump off button to turn the pump on
4		Proceed immediately to the next step.

Once the flow rate is turned on, immediately you will see the gage 1 pressure increase.

Table 29. Steps to Set the Backpressure Regulators

Step	Press	Description
1		Watch pressure gauge 1 increase. Turn back pressure regulator 2 clockwise and watch gauge 1 increase. Dial back counterclockwise as the gauge approaches 5000 psi. Caution: If you do not dial the backpressure regulator so that the pressure climbs to 5500 psi, the pump will turn off.
2		Once 1 reaches 5000 psi, gauge 3 will begin to climb. Adjust knob 4 clockwise 4-5 turns. Pressure will increase to ~2500 psi. Adjust the knob clockwise/counterclockwise until the gage reads 2500 psi.
3		Repeat steps for gauges 5, and 7 by adjusting knobs 6 and 8 respectively. Adjust pressures to 1250 and 800 psi respectively.

Users may establish their own pressure set points based on their own extraction requirements and testing.

Heater Operation

Setting Temperatures

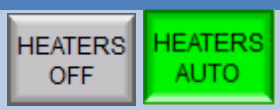
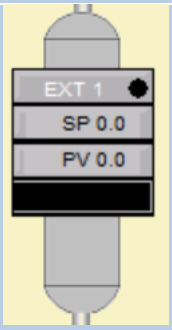
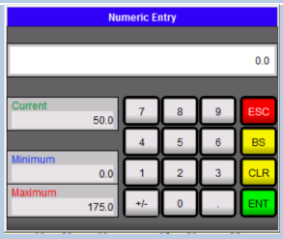
WARNING: Using the heaters can cause the surfaces to be hot.

Temperature set points for the heaters are controlled from the touchscreen. When the system is powered on, each of the heated zones, preheater, extractors (2), collectors (3) and post

heater (optional) will be visible and a SP (set point) value and PV (present value) value will be shown in a box superimposed over the image of that zone.

A green light in the upper right corner of each box will be visible when the heater is operational. The following gives instructions on switching the heaters on and off and adjusting the set point:

Table 30. Steps to Set Temperatures

Step	Press	Description
1		In the upper left hand corner of the touch screen, press the "Heaters Off" button. The button will turn green and read "Heaters AUTO". The heaters are turned off by simply pressing the button again (Figure 3).
2		Select the heater to be adjusted by touching the heater icon on the touchscreen. When the heater is on, the black dot will turn green and the black bar will have a red indicator showing the proportional power being delivered to the heater.
3		Enter the desired set point into the SP field. Each heater can be set this way.

The preheater will not function without the pump on. Once a flow path has been established, the icon for the preheater will light up and the set point can be adjusted.

Compensating for Axial Temperature Gradients

Tools required: Thermocouple, K Type, with Kapton tape insulation and digital reader.

Every column that is heated with a uniform thermal blanket or uniform temperature oil bath will

have an axial temperature gradient in the fluid. This temperature gradient is there even if the system is reporting a single temperature. For example, with an oil bath, the thermocouple is reporting the temperature of the oil, not the temperature of the thermal gradient in the column. The same situation occurs with blanket heaters as deployed in this system. The heaters in this system have thermocouples that are located in the middle of the column so that an average column temperature is reported. You will notice that the top of the extractor will be warmer than the bottom.

Running under temperature gradient conditions is an acceptable way to operate a method and has produced relatively reproducible and acceptable results. However, if a more uniform axial temperature is desired, the preheater can be used to compensate for the axial temperature gradient.

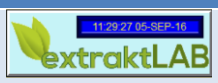
To compensate for the axial gradient, we recommend that the set point of the preheater be set ~12°C higher than the extractor temperature to counteract the axial temperature gradient. After setting the temperature at a higher value, wait for 20 minutes to check the column differential at the inlet and outlet of the extractors. The blanket heaters on the column will automatically adjust power to accommodate the higher inlet temperature. An external thermocouple is used to check the inlet and outlet temperature differential. If the differential remains high, increase the preheater temperature to 17°C higher than the extractor temperature. Wait for 20 minutes and re-measure.

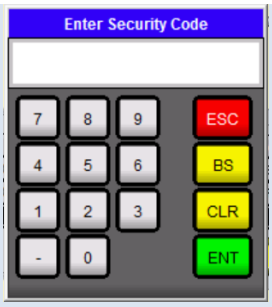
Setting Proportional & Integral Heater Control Values

The heaters use thermocouples to measure the temperature of the heater and then subsequently adjust the power to the heater. When the heater is at the set point, only a small amount of power equal to the thermal load is required to maintain the set point. When the thermocouple registers a large difference between the set point and the actual, the system will ramp up the power depending on the integral and gain parameters that are set by the manufacturer.

If you experience large fluctuations in measured vs set point temperature, you will need to adjust the integral and gain parameters. To access the parameters, follow these instructions:

Table 31. Steps to Access the Parameter.

Step	Press	Description
1		Push and hold the logo until the security code dialogue shows up.

2		Type in key code 3107.
3		Use the following table as a starting point for setting the PID values.

The following values are given as a guide. The high temperature alarm number should NOT be adjusted as it is set to give a warning in case of a high temperature condition with a heater. In general, if the heater is fluctuating, increase the integral time.

Table 32. Suggested Parameters

Parameter	Pre	E1	E2	C1	C2	C3	Post
PID Gain	20	75	75	75	75	75	75
PID Integral	1	2	2	2	2	2	1
PID Max Output	30	90	90	90	90	90	90
High Temp Alarm	130	90	90	90	90	90	130

Sensors and Alarms

The following table details the types of sensors, measured parameters, alarms, trigger criteria and action for each alarm. Some alarms have on screen notification that must be cleared or acknowledged before resetting.

Table 33. Table for Sensors and Alarms.

Number	Type	Parameter	Alarm	Criteria	Action
1	Safety	Temperature Switch	Red Light	Switch open at over temp condition	System shut down
2	Warning	CO_2 Meter	Red Light, on	9000 ppm for	Turn off pumps

			screen notification	20 sec	and shut valves
3	Warning	Low Inlet Pressure	Yellow Blinking, on screen notification	<640 psi for 20 sec	Turn off pumps
4	Warning	Collector High Pressure	Yellow Blinking, on screen notification	P1 Pressure > 4000 psi	Turn off pumps
5	Warning	Pump High Pressure	Red Light, on screen notification	Pump Pressure > 5500	Turn off pumps
6	Warning	Pump Inlet Temp	Yellow, on screen notification	Temp>10°C within 10 min of startup and maintain this criteria throughout the run.	Turn off pumps
7	Warning	Post Pressure Transducer High Limit	Yellow, on screen notification	P3> 1200 psi	Turn off pumps
8	Warning	High Temp Limit Warning	On screen Notification	Temp switch max less 10°C	Turn heaters off
9	Method Parameter	Time of day Hold	Yellow Blinking		
10	Method Parameter	Method Running	Green Solid		
11	Method Parameter	Manual Method Pause	Yellow Blinking		

12	Method Parameter	End of method	Yellow Blinking, Buzzer		
13	No Flow	Preheater Temp too High, Pre pump temp too low	Yellow, Vapor Lock, On screen warning		Turn off pumps
14	Communication	Communication and module fault	Yellow light, on screen notification	PLC monitoring	On screen notification
15	Valve Closure	Valve error	Yellow light, on screen notification		Shut down pumps
16	No Flow Alarm	Vapor lock in pump	Yellow light, on screen notification	Temp sensor - Temp chiller > 5°C	Just notify, no action

How to Determine if the CO_2 Cylinders Are Empty

There are several alarms and sensors that allow you to detect a depleted cylinder. They are listed as follows:

- The inlet pressure will dip below 640 psi and remain there for more than 20 seconds. The HMI will automatically notify you of this condition and the signal tower will blink yellow until you correct the error.
- The preheater temperature will increase due to lack of flow. This is not tied to any alarm but if you are experiencing heater over set point conditions, it is likely you have a vapor lock or are out of CO_2. High preheater temperature is a good indicator that there is no flow.

Alarms and reminders have been set up to help detect these events.

Changing CO_2 Cylinder

WARNING: To avoid bodily injury, ensure that CO_2 tanks are tethered to a solid object.

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WARNING: To avoid injury, ensure that the supply tube is vented and the cylinder valve is turned off.

WARNING: To avoid injury from uncontrolled tubing motion from gas leakage, ensure that all tubes are secured before disconnecting.

1. CO_2 cylinders must be shut off at the valve on top of the cylinder before servicing.
2. Turn off the extractor power.
3. Close the 1/4” (Extrakt 110 and Extrakt 110+) or 3/8” (Extrakt 140) inlet valve on the side of the instrument. Vent the tubing to remove gas by opening a fitting ¼ turn to allow the compressed gas to leak out. DO NOT REMOVE THE FITTING. Just loosen the fitting. Once the gas has exited, tighten the fitting. Loosen and tighten the Swagelok fittings according the instructions in: MP-006 Making and Breaking Connections.
4. Loosen the brass CGA connections with the supplied 1-1/8” wrench. Hold onto the CGA assembly as you loosen the connections.
5. Remove the empty tanks and replace with full tanks.
6. Move the manifold from the empty cylinders to the full cylinders.
7. Reattach the CGA assembly with the 1-1/8” wrench.
8. Open the CO_2 valves on the CO_2 tanks to feed CO_2 to the CO_2 pump.
9. Open the inlet valve on the extractor.
10. Turn on the extractor main power by turning the power switch located below the touchscreen.
11. Prime the pump as previously described.

NOTICE: A pump that has been vapor locked will not flow into an extractor that is at pressures greater than 800 psi. You must prime the pump or start the pump into an extractor that is at low pressure.

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Grind Specifications

The instrument is loaded using the provided nylon mesh bags, your ground product, a two piece PVC addition system, a tamping rod, a funnel and a scoop. Product should be uniformly ground to around 200 +100/-0 µm. Grind size greatly impacts extraction efficiency as well as bag lifetimes. The grind should be free of fines otherwise they will elute through the bag (10 micron) and make your extract green and clog the BPR 1 with light green/white particles. It is the responsibility of the customer to provide a uniform grind that is free of fines.

Unloading and Loading the Instrument

WARNING: To prevent bodily injury, ensure that the system is vented before loading and unloading

WARNING: To prevent bodily injury, wear all PPE including steel toed shoes.

Required Tools and Equipment

- Nylon mesh bag
- PVC addition system
- Tamping Rod
- Funnel
- Scoop
- 1/2” and 9/16” wrenches
- Top Removal Tool
- Orange dead blow hammer
- Lifter Plate w/ Screws
- Eyebolts (Extrakt 140 only)

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Extractor and Collector Components

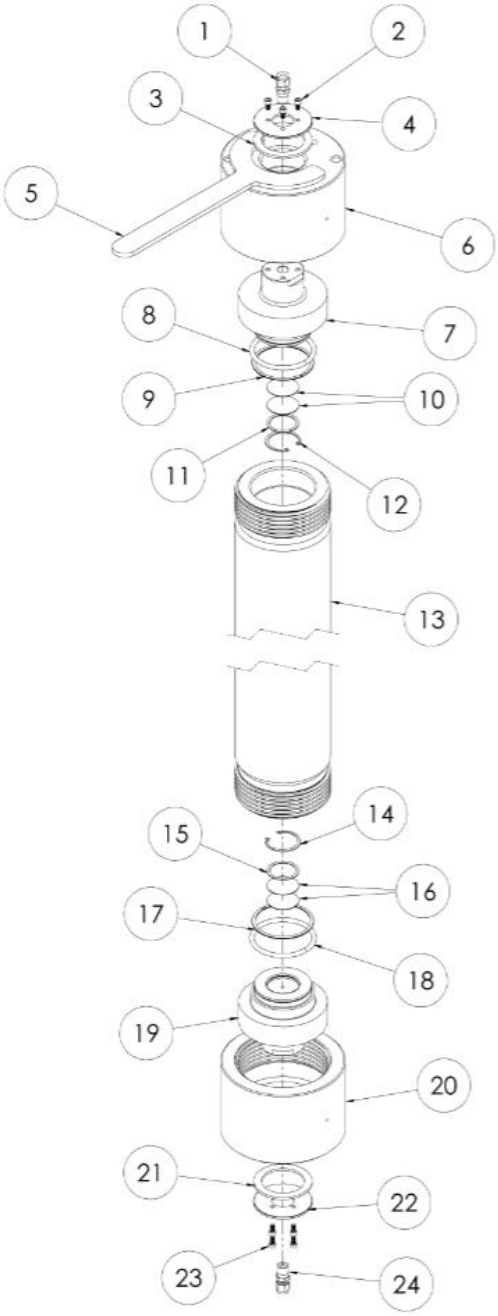

Figure 23. 5L extractor column.

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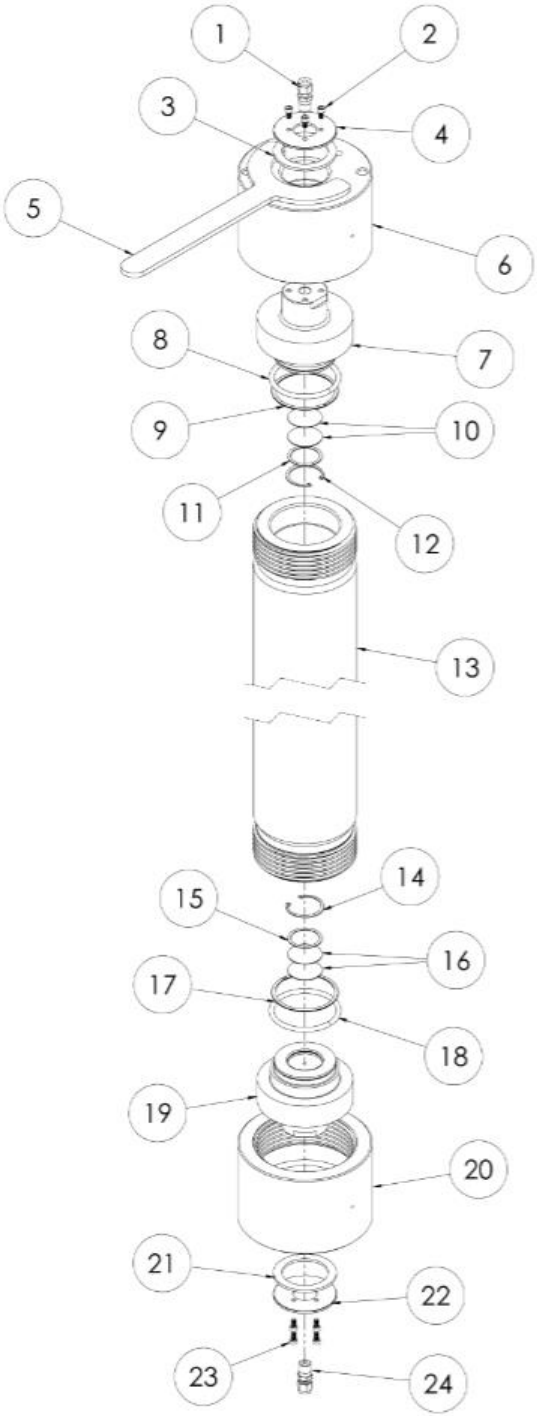

Figure 24. 20L extractor column.

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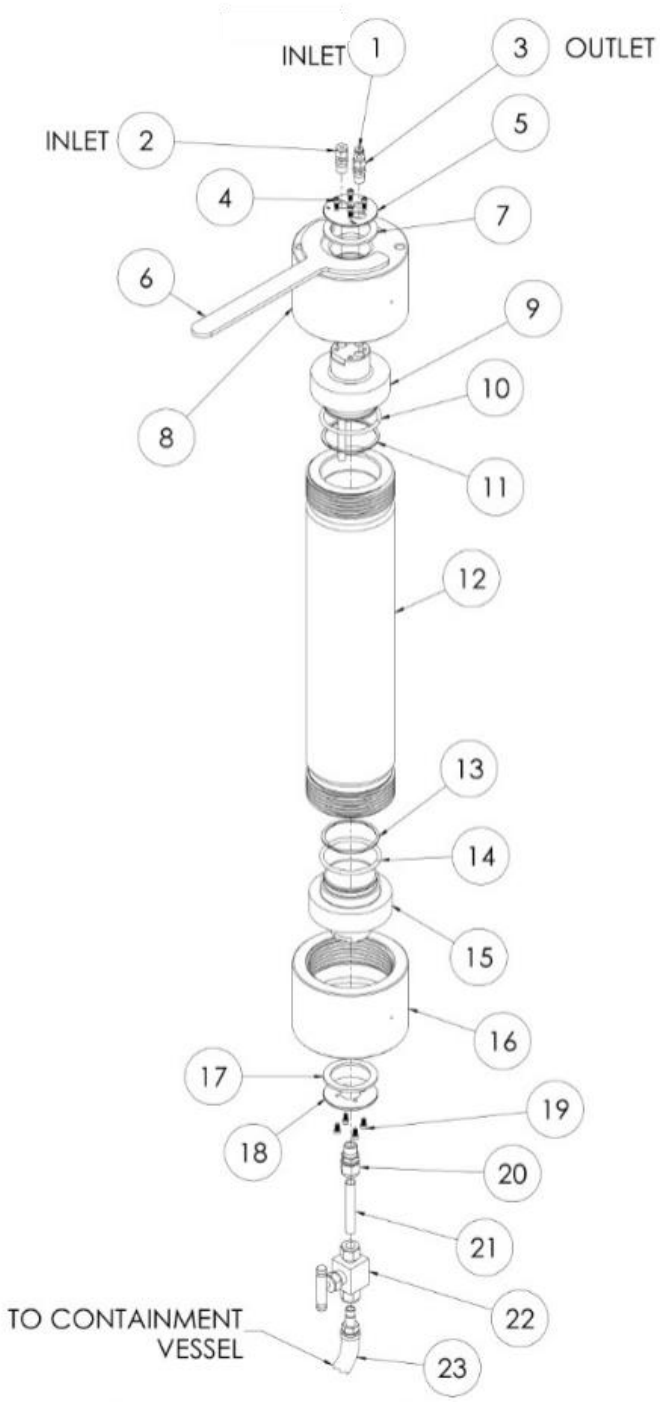

Figure 25. 2.5 L Collector Column.

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Table 34. Component Description

Items	5L	20L	2.5L	Description
	Location			
Spanner Wrench	5	5	6	Wrench to remove cap nut
Lifter Plate	4	4	5	Plate to lift cap with nut during removal
Compression fitting, first end	1	1	1,2	Extractors: Outlet for CO2 Collectors: Inlet for CO2 or Ethanol Inlets
Upper Cap Nut	6	6	8	Keeps cap tight to body
Upper Cap	7	7	9	Conveys fluid from the outside to the inside of the tanks
Body	13	13	12	Tanks for containing extracts or matter to be extracted
Buna O ring	8, 17	8, 17	10,14	Sealing rings
Retainer	9, 18	9, 18	11,13	Retains sealing rings in place
Filter Assembly	10,11,12, 14, 15, 16	10,11,12, 14, 15, 16		Filters hold filter bags in vessel

Lower Cap	19	19	15	Conveys fluid from the inside to the outside of the tanks
Lower Cap Nut	20	20	16	Keeps cap tight to body
Compression Fitting, second end	24	24	20	Extractors: Inlet for CO2 Collectors: Outlet for CO2 or Ethanol Inlets
Containment Interface			22	

Top Extractor Cap Nut Removal

NOTICE: Make sure the extractor to is vented to atmospheric pressure before filling.

WARNING: To prevent bodily harm, proper PPE must be utilized during cap nut removal procedures.

- Verify that the extractor does not have any pressure.
- Ensure that inlet and outlet valves are closed.
- Vent extractor using the vent valve.
- Once vented, remove the top of the extractor, start by loosening the swage fittings at the unions.
- Remove swage fittings at the unions.

NOTICE: Be careful when removing the extraction column top. There is a pinch point between the bulkhead and the column top.

WARNING: Cap nut is heavy. When you remove the cap nut, you must have a good grip on it otherwise it could cause physical harm.

- If not already attached, secure the lifter plate to the cap using the provided screws.

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- Break the seal by inserting the provided bar or spanner wrench into one of the receiving holes in the cap and pushing the bar counter-clockwise. It may be necessary to use the provided dead blow hammer to tap the bar loose.
- The cap may be unscrewed by hand or by using the bar to assist you.
- If not already attached, secure the lifter plate to the cap using the provided screws.
- Change the O-ring on the cap insert by removing the retention ring and sliding the O-ring off.
- Place new O-ring on and replace retention ring.

Filling the Extractor with Material (Extrakt 110 and Extrakt 110+)

- Take a small amount of material ~1 cup or 250mL and add to the bag before inserting the bag into the extractor. The weight of the material will allow the bag to reach the bottom of the extractor. If the bag doesn't reach the bottom of the reactor, voids in the column can form when filling that will reduce the amount of material that can be added.
- Place the PVC reducer onto the extractor with the larger end facing down.
- Pull the strings of the bag through the center hole in the PVC reducer and over the outside.
- Place the funnel into the PVC assembly and begin filling with the scoop.
- When the bag is ~ 1/4 full, tamp down the material lightly with the tamping rod. The idea is to prevent any voids from forming in the extractor column, not to compress the product.
- Continue filling and tamping when the column is 1/2 full, 3/4 full and when the column is full. Leave ~ 1" of headspace in the extractor column for the knot. After filling has been completed, pull the draw string tight and tightly wrap the last 1" of the nylon bag with the draw string with a Prusik knot.
- Replace top and tighten by screwing top clockwise till it locks into place.
- Replace Swage nut and tighten.

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- Replace Swage tubing and tighten fittings ¼ turn past finger tight to seal.
- The filled extractor is ready to be processed.

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Filling the Extractor with Material (Extrakt 140)

- Place the rubber boot on a work surface, with the larger end facing down.
- Place the extractor bag inside the boot, and curl the outside opening over the top of the narrow end of the boot.
- Secure the bag using the Velcro strap.
- Pull the remainder of the bag out of the boot. The apparatus should now be a long back with the black rubber boot acting as a funnel.
- Take a small amount of material ~1 cup or 250mL and add to the bag before inserting the bag into the extractor. The weight of the material will allow the bag to reach the bottom of the extractor. If the bag doesn't reach the bottom of the reactor, voids in the column can form when filling that will reduce the amount of material that can be added.
- Place the bag with funnel into the column. Material can now be added through the funnel into the bag.
- When the bag is ~ 1/4 full, tamp down the material lightly with the tamping rod. The idea is to prevent any voids from forming in the extractor column, not to compress the product.
- Continue filling and tamping when the column is 1/2 full, 3/4 full and when the column is full. Leave ~ 1" of headspace in the extractor column for the knot. After filling has been completed, gently pull up on the black rubber boot. It will pull free from the sock so that the rubber boot and the Velcro strap can be set aside.
- Pull the draw string tight and tightly wrap the last 1" of the nylon bag with the draw string with a Prusik knot.
- Replace top and tighten by screwing top clockwise till it locks into place.
- Replace Swage nut and tighten.
- Replace Swage tubing and tighten fittings ¼ turn past finger tight to seal.
- The filled extractor is ready to be processed.

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Performing a Manual Extraction

Once the extractor has been filled and all the extractor column fittings have been tightened an extraction run may be performed. The way to use time efficiently if an extractor column is not filled is to fill one while the other extractor system is extracting.

- Turn on the heaters by pressing the “Heaters Off” button in the upper left hand corner of the touchscreen. Allow heaters to equilibrate for at least 1/2 hour before beginning a run.
- Turn on the chiller. It can take the chiller 5-10 minutes to come to the set point.
- Ensure that the vent valve for the extractor to be used is closed by turning the valve clockwise.
- If this will be the first run of the day, neither extractor is pressurized and there is no pressure in the collection vessels, open the valves to the column that will be extracted and valve 5 to establish a flow path.
- Turn on the CO_2 at the tanks and open the ball valve where the gas enters the extractor.
- Wait for the pressure of the system to equilibrate to at least 750 psi. This should only take a few minutes. If the pressure doesn’t reach 750 psi, verify that there is enough CO_2 available to do a run.
- Once the pressure has stabilized, turn the CO_2 pump on by pressing the “Pump Off” button. Set the pump at your desired flow rate (Extrakt 110 and Extrakt 110+ only).
- As the pressure builds in the system, verify that the back pressure regulators are set to the values in your extraction method. Adjust pressures as necessary.
- Extraction times will vary from user to user.
- When the run time has elapsed, turn the CO_2 pump off.

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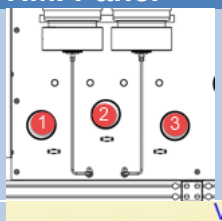
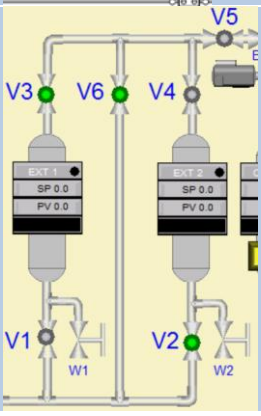
Transferring CO_2 from Extraction Column to Extraction Column

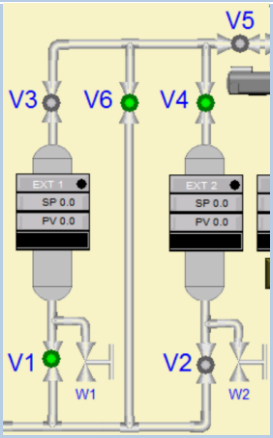
At the end of the first run of the day and every subsequent run performed that day, the pressure in the extraction column that was run is used to partially pressurize the other extraction column. This serves three purposes. The first purpose is to save time. It takes time for the pump to fill the extraction column. The second is to save CO_2. Having the column to be run partially filled with CO_2 before the pump starts means less CO_2 is needed to fill it. The final reason is a combination of the first two but concerns venting the remaining CO_2 in the extraction column that is complete. When the run is complete the remaining pressure in the extraction column is vented to atmosphere and the lower the starting pressure, the less waste and the quicker this venting happens.

Before the pressure can be transferred from one column to the other, the 2nd column should be filled with product and all the fittings sealed. See loading and unloading.

Note: When transferring, flow must always travel in the direction of normal operation; namely, out the top of the column which is completed, and into the bottom of the column to be ran. Adherence to this protocol will extend the lifetime of the extraction bags.

Table 35. Steps to Transfer CO_2 from Extraction Column to Extraction Column

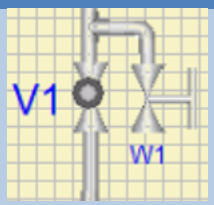
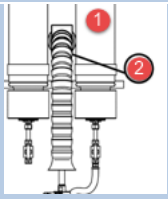
Step	HMI Panel	Description
1		Locate manual transfer valve 2 on the front panel. It is located in close proximity to the extractors. Vent valves 1 and 3 are not transfer valves.
2		Transfer from Ext 1 to Ext 2. Close V5. Open V3. Open V2. Open Manual Transfer Valve 2 (V6) slowly. Gradually open the valve 1/2 turn over a 30 second interval. The pressure transfer process takes several minutes. Allow pressure to equilibrate. You can verify that the pressure transfer is complete when the values of both extractor

		pressure gauges are equal. Close the transfer valve and the transfer process is complete.
3		Transfer from Ext 2 to Ext 1. Close V5. Open V1. Open V4. Open Manual Transfer Valve 2 (V6) slowly. Gradually open the valve 1/2 turn over a 30 second interval. The pressure transfer process takes several minutes. Allow pressure to equilibrate. You can verify that the pressure transfer is complete when the values of both extractor pressure gauges are equal. Close the transfer valve and the transfer process is complete.
4		Open the valves on the extractor column to be run and be sure to close the valve on the column that has been extracted.
5		Turn on Valve 5.
6		Turn the pump on and begin pumping.

Venting the Extractor

Extractors may be vented between runs. The following procedure is used to vent the extractor.

Table 36. Steps to Vent the Extractor

Step	Press	Description
1		To accomplish venting of either extractor, press the inlet valve V1 or V2 so that it turns green.
2		Open vent venturi (1) damper located on the front panel.
3		Open VV1 or VV2 slowly so that the tank empties in 10-15 minutes.
4		Turn off VV1, close the damper 1.

Sequences and Methods

Creating and Editing Methods

Users may perform extractions manually using the touchscreen to control the pumps, valves and temperatures. To make the instrument easier to run with minimal user interaction, it is equipped with an automated method edit feature. This allows users to predefine the extraction conditions: run time, flow rate, valve actuation, temperature, peripherals, post method actions.

Table 37. Steps to Create and Edit Methods

Step	HMI Panel	Description
1	RUN EDITOR	Press run editor, the sequence editor is called up.
2	METHOD EDITOR	Press method editor to edit method.

The following screen will appear:

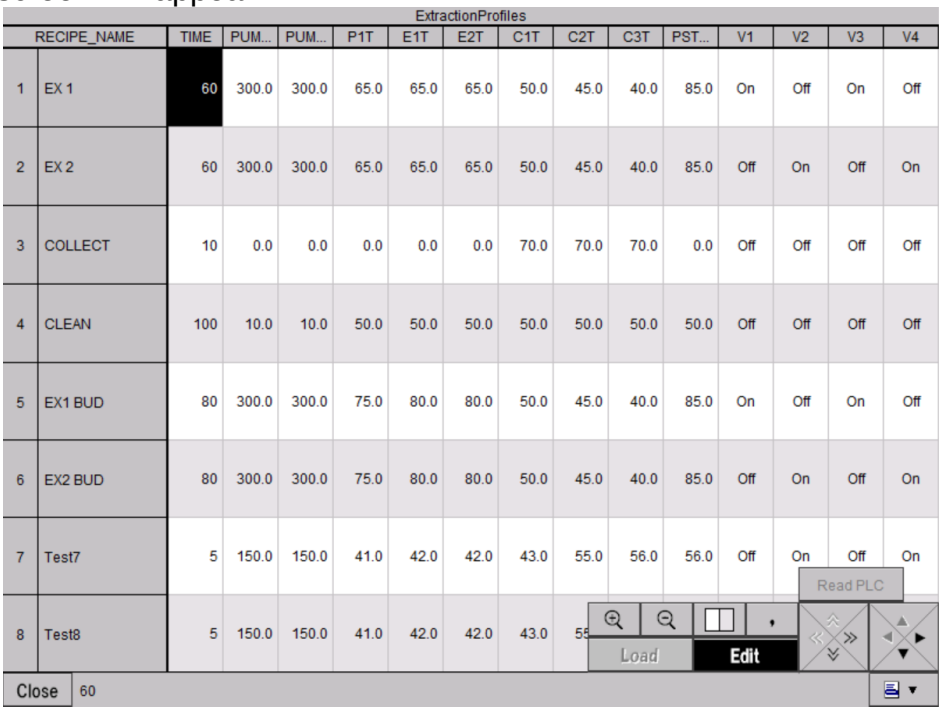


Figure 26. Example of screen for editing methods

To edit or make a new method, click on the recipe name to highlight the row. Then press edit.

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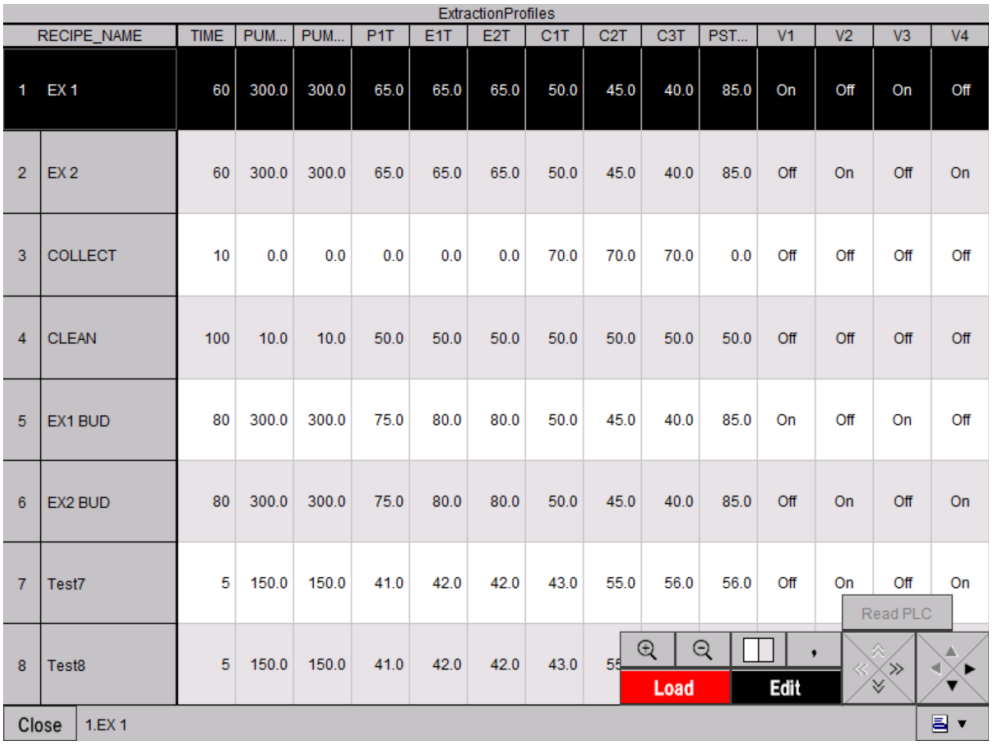

Figure 27. Example of screen for edit or make a new method.

In the edit mode, you will be able to modify the following parameters:

Recipe Name- The name of the recipe
Min- The time in minutes that the pump will run
PM1- Sets rate of pump (Extrakt 110)
PM2- Sets rate of 2nd pump (Extrakt 110+)
PM3- Sets rate of ethanol pump
PREH- Preheater temperature in °C
EXT1- Extractor 1 heater temperature in °C
EXT2- Extractor 2 heater temperature in °C
COLL1- Collector 1 heater temperature in °C
COLL2- Collector 2 heater temperature in °C
COLL3- Collector 3 heater temperature in °C
Pos- Post heater temperature in °C
V1 - Controls whether Extraction Column 1 inlet valve is open (On) or closed (Off)
V2- Controls whether Extraction Column 2 inlet valve is open (On) or closed (Off)
V3- Controls whether Extraction Column 1 outlet valve is open (On) or closed (Off)
V4- Controls whether Extraction Column 2 outlet valve is open (On) or closed (Off)
V5- Controls whether Exit valve is open (On) or closed (Off)
V8- Controls whether CO_2 can exit to atmosphere in flow path (On)

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V7- Source CO_2 inlet valve
V94- Recycler CO2 inlet valve
PSTP- Controls if the pump continues to run after the run time expires (Typically “Off”)
PSTH- Controls if the heaters continue to run after the run time expires
PSTC- Controls the on off switch for the chiller.
FILL - Enables auto fill function if recycler is in place

The fields are entered by touching the menu button on the lower right corner of the screen in the field and then touching the “Edit” button until it is grey. The fields can then be touched one by one to enter the desired values into them.

Once all of the fields have been entered, the program can be loaded. This is accomplished by touching the number of the desired recipe at the far left and then touching the red “Load” button. This will actuate the valves and load the parameters for the run into the system. It does not enable or disable the heaters or the pump, so pre-heating or pre-pumping can be done.

Once the recipe has been loaded, the recipe screen is closed by touching the close button on the lower left of the screen. If any changes to the recipes have been made, you will be prompted whether or not to save them.

On the main screen the “Start Run” button is now available. Pressing this button will start the pump at the specified rate for the specified time, the selected valves will open, as well as enable the heaters if they were not already enabled.

At the end of the run the pump and heaters will either remain on or off depending on the values entered into PSTP and PSTH in the recipe. Typically, the pump is shut off and if another run is to be done, the heaters are left on.

Types of Methods

- Standard Run Extraction Column 1: Standard flow rate, run time and temperature, Valves 1,3 and 5
- Standard Run Extraction Column 2: Standard flow rate, run time and temperature, Valves 2,4 and 5
- Overnight Run: Both Columns run simultaneously at the standard flow rate and temperature but 2.5 times longer than the standard run.
- Cleaning Run. This can be set up to either pump through the columns or to bypass the columns using the pressure transfer line. Standard flow rate and runtime, with slightly elevated temperatures to facilitate cleaning. Some methods utilize high pressure.
- Collection Run. This run can be utilized at zero flow with only the collector heaters on.

Creating and Editing Sequences

To make the instrument easier to run with minimal user interaction, it is equipped with an automated sequence feature. This allows users to load different methods and run them in a sequence. To edit a sequence, push the method editor button on the HMI panel. The following screen will appear:

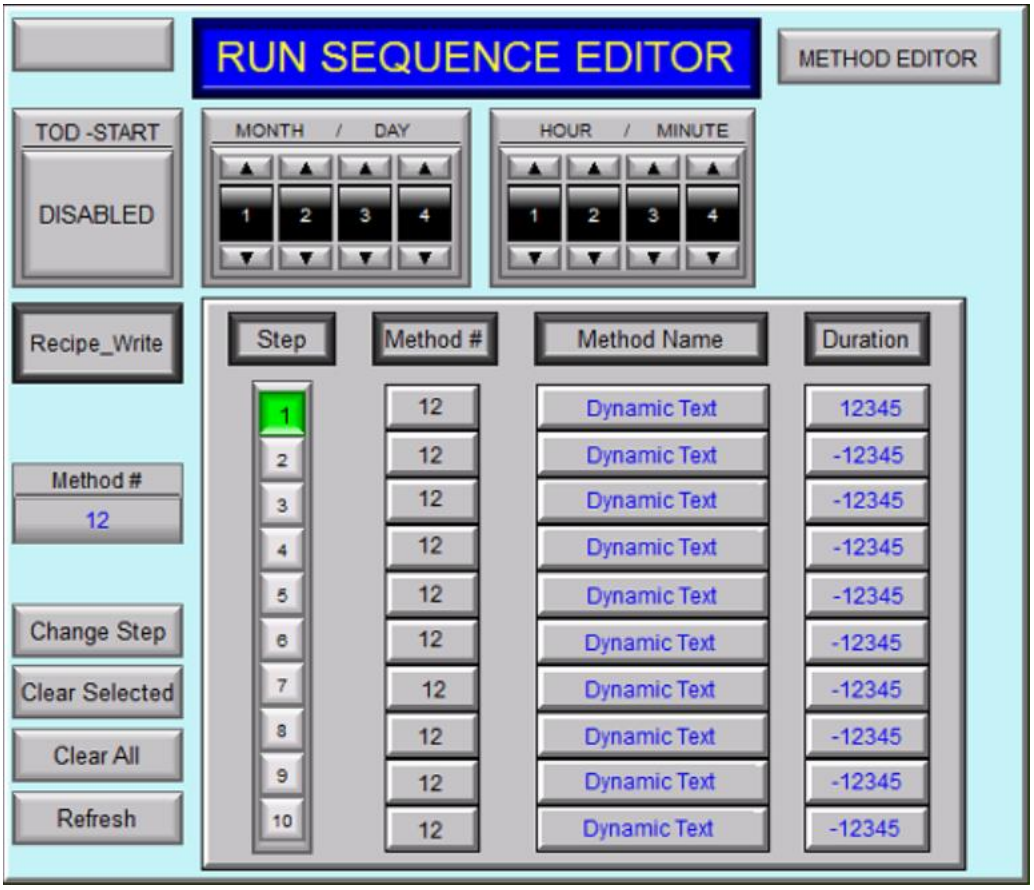

Figure 28. Example of screen for editing sequences.

- Before loading a method, clear the system by pressing Clear All, followed by Refresh
- To load the first method, press the step 1, then press change step.
- Press Method # and input the corresponding number of method you want to change.
- Continue loading methods by pressing step 2. Then press change step.
- Repeat until all the methods in the sequence are loaded.
- Press Exit.
- To have the sequence start at a later time, press TOD-START and set the time of day.
- Enter in time to start.

- Press Exit.

Starting, Pausing, and Aborting a Sequence or Method

- To run a sequence, press, Start Run.
- To abort a sequence, press Abort Run.
- To pause a sequence, press Pump Off
- To edit a method, press Method Editor

Examples

Sequence Load Screen

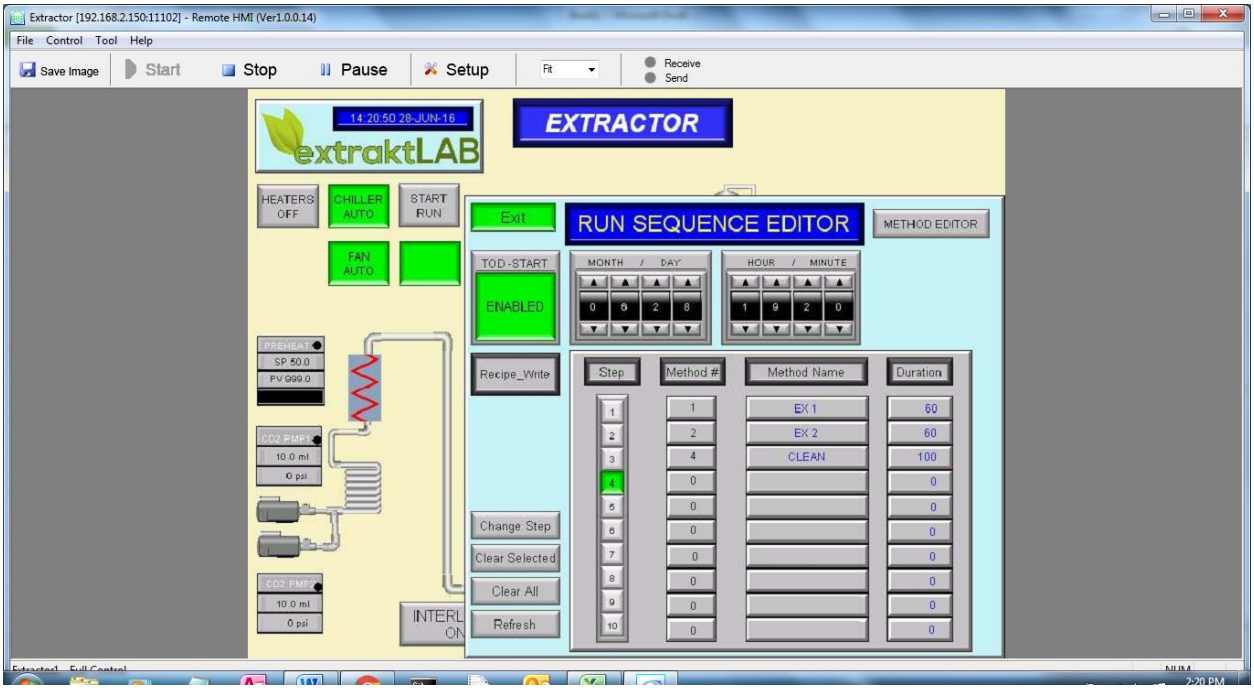

Figure 29. Example of sequence load screen.

The sequence would run two extractor methods followed by a cleaning method. The Time of Day Start has been created to start on 05/25/2016 at 1920 hours.

Method Running Extractor 1

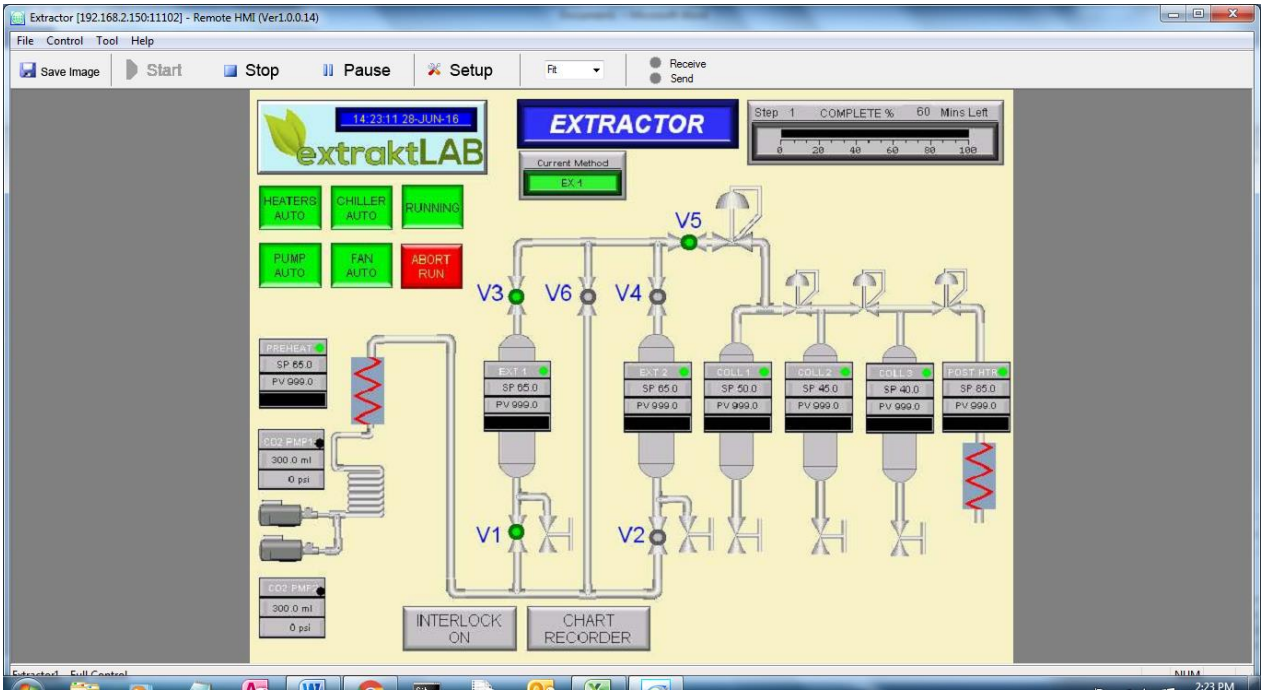

Figure 30. Example of method running screen.

This shows a method running at 300 ml/min on both pumps. The heaters are on, the pump is on, the fan and chiller are on. Extractor 1 is extracting and the set points for the heaters are 65, 65, 50, 45, 40, 85.

Collecting and Containment Systems

WARNING: Collection into improvised plastic, glass, or thin walled metal vessels can result in explosive decompression. Serious bodily injury and/or loss of product can occur. Only collect material into suitable containers with proper safety protocols.

Requirements: Use of eye and glove protection is mandatory.

Containment systems are important for prevention of explosive decompression during collection and also for isolating the product from the environment to prevent contamination.

The containment system is comprised of the following components:

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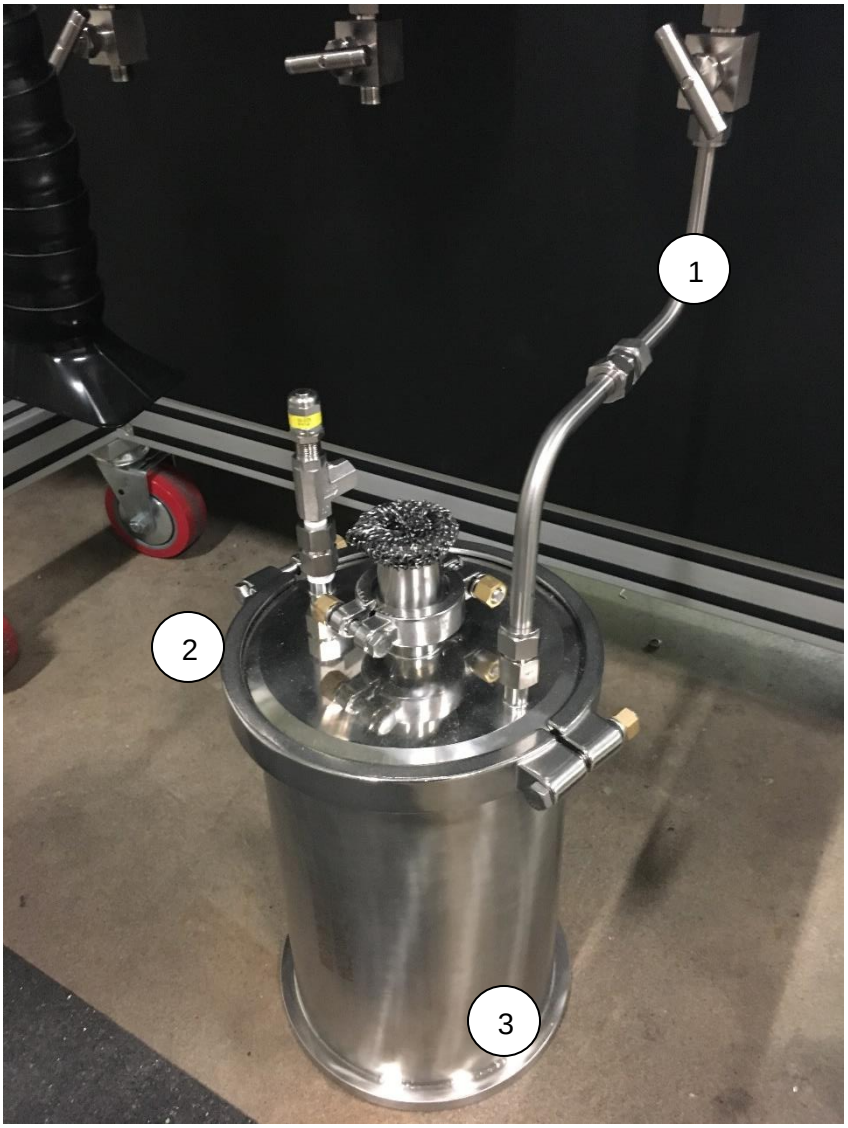

Figure 31. Containment system showing mating components including the rigid high pressure collection hose (1), triclamp sanitary clamp connector (2) vessel (3).

To assemble, place buna ring on vessel and mate with cap assembly. Triclamp sanitary clamp connector (3) can be tightened with the appropriate wrench. Collection may be started at any time after an extraction is completed but we recommend collecting after multiple runs have been processed to increase throughput. Typically, collection would occur each day. Collect using the following procedure:

- Turn off pump flow.
- Turn the heaters on and adjust the temperature to 50°C - 70°C for each collection vessel if they are not already on. Ensure the heaters have been on for 1/2 hour to allow

the oils to warm up completely before collection begins.

- Collection starts with the 3rd (lowest pressure) collector and proceeds to the 2nd and finally the first pressure collector. Place the containment system (2) under the collection valve (5) and screw rigid collection tubing (6) onto the valve and tighten with a 13/16" wrench.

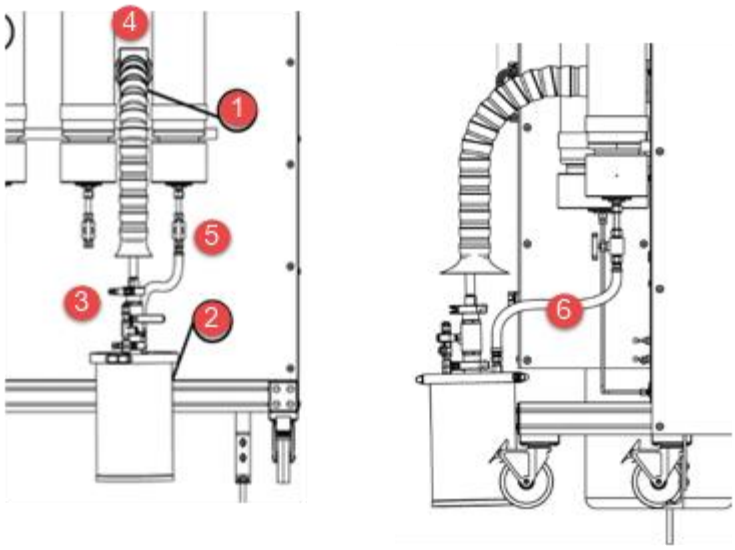

Figure 32. Figure showing the connection of the containment system. (1) vacuum hose snorkel, (2) containment system, (3) collector lid, (4) damper, (5) collection valve, and (6) rigid tubing.

⚠ WARNING: Failure to comply with instructions could lead to bodily injury. Ensure no obstructions block flow path through collection vessel

! **NOTICE:** We recommend using a heat gun to warm the rigid tubing during collection. The extracted oils can condense in the tubing and clog it if heat is not applied

⚠ WARNING: The use of a heat gun presents a burning hazard. Follow instructions provided by the manufacturer of the heat gun.

Follow these instructions for initial collection.

- Open the front vent damper (4) on the instrument.
- Place the snorkel (1) over the outlets on the collector lid (3).
- Very slowly open the 1/2" swage valve (5) on the bottom of the collector. Do not open the valve more than 1/8 of a turn at the start of collection as the vented CO_2 flow will

exceed the capacity of the vent to draw the CO_2 away.

- Once the valve has been opened enough to allow CO_2 to proceed through the rigid tubing into the collection vessel, open the valve until you can hear sputtering in the collector tube.
- Flow through the rigid tubing will decrease as the pressure in the collector decreases. This should be compensated for by opening the valve further in order to prevent excessive CO_2 from building up in the collection vessel.
- When the pressure reading on the BPR has reached 0 psi, open the valve fully to ensure there is no residual pressure in the collector.
- Repeat steps for collectors 2 and 1. Collectors 2 and 1 are at higher pressures than 3 and will take more time.
- After the extract has been removed from all 3 collectors, the instrument can be cleaned.
- Turn the collector heater off once the material has been collected.
- Once all 3 collectors have been vented the contents of the evacuation vessel can be transferred to a sonicator for post processing as desired.

Instrument Cleaning

WARNING: There may be residual pressure in the collectors so be careful when removing valves. Vent before opening.

Recommended Cleaning Interval

Table 38. Recommended Cleaning Interval

Procedure	Interval
Collector Cleaning	As required, at least 2x per week
Lower Collector Cleaning Run	Every Collection
Post collector Cleaning	Every Week
Terpene Collection Cleaning	As needed/every 2 weeks
Complete Tear Down	Every 1500 runs
Heat Exchanger Cleaning (Recycler)	At the end of every workday
Recycler Cleanout	As needed/every 2 weeks

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Collector Cleaning

After a collection has been completed and the system has been depressurized, the residual oils should be cleaned from surfaces. This allows users to get a more complete estimate of the yield produced by the extraction process and can be used to eliminate cross contamination of different varieties of product. These steps can be performed during the collection process once a collector has been vented.

Required Equipment

- Sonicator
- 9/16” and 13/16” wrenches
- Food grade EtOH
- 1/4”, 1” and 3” tube brushes
- Spatulas

Disassembly for Cleaning Purposes after Collection

- Remove the venting valve from the bottom of Collector 3 using a 13/16” wrench. Loosen the 1/2” swage fitting between the valve and the tank adaptor. Place the venting valves into the sonicator with enough cleaning solution to submerge the connections.
- Turn the sonicator on and set the heater to 40°C to aid in dissolving the oil from the control surfaces.
- Remove the bottom nut of the collector by unscrewing the lower cap nut.
- Scrape the interior walls using a spatula.
- Place a suitable reservoir below the collector and squirt food grade EtOH into the reservoir using the supplied squirt bottle. The EtOH will drain from the collector into the reservoir. This material should be retained and added to the evacuation vessel for winterization.
- Continue rinsing the collector with EtOH until the effluent runs clear.
- Repeat this process on Collectors 2 and 1.
- Remove the rigid tubing from the collection vessel and rinse with EtOH until clean. These items may be placed into the sonicator to aid in the cleaning process.
- Use the tube brushes and spatulas to assist in cleaning the inner control surfaces of the individual items.
- Once the oils have been dissolved from the surface of the items to be cleaned, rinse them with clean EtOH and set them on a clean surface to dry.
- Reinstall the valves on the collectors and close them.

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Cleaning Run

After the collectors have been reassembled the extractor flow path can be cleaned to maintain its performance and extend the lifetime of the BPR seals, extractor bags pneumatic and transfer valves.

Cleaning the system is important to ensure that the transfer lines throughout the system are cleaned out and do not build up clogs due to waxes. If 3 or more runs are performed a day, cleaning every 1-2 days is recommended. If fewer runs than this are performed, system cleaning can be done less frequently.

There are two methods for cleaning:
Supercritical cleaning
Ethanol Cleaning

Supercritical CO_2 Cleaning

The supercritical method bypasses the extraction columns with the transfer valve and introduces 50ºC supercritical CO_2 to the valves and collectors only. To accomplish this, you will need to follow this procedure:

1. Set preheater temp to 50ºC
2. Turn off all extractor valves, V1, V2, V3, V4.
3. Open V5.
4. Open V6 via manual transfer valve.
5. Open V8.
6. Turn on pump at maximum flow rate.
7. Adjust BPR 1-4 to 5000 psi.
8. Run for 20 minutes, then reset BPRs to 5000, 2500, 1250, 800 respectively.

Otherwise, run method at normal operating pressures without adjusting to high pressure.

High Pressure Ethanol Cleaning

The ethanol cleaning method bypasses the extraction columns and the transfer valve and introduces room temperature ethanol to the valves and collectors only. To accomplish this, you will need to follow this procedure:

1. Close V5.
2. Open manual ethanol cleaning valves in the rear panel. One valve at a time.
3. Turn on pump at 36 mL/min
4. Do not adjust any BPR.
5. Run for 60 minutes.
6. Collect ethanol from collector via 1/2” collector valve at the bottom of the collector.
7. Close valves and repeat.

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Terpene Collection System

The terpene collection system has been designed to allow users to reclaim terpenes that have not been collected in any of the collectors or the post collector. The collected terpenes can then be added back into the extracted oils improving the flavor.

The terpene collector (1) shown in the following figure is an add-on module that screws onto the post collector (4). Terpene collection should be performed weekly or whenever users notice terpene odors in the effluent CO_2.

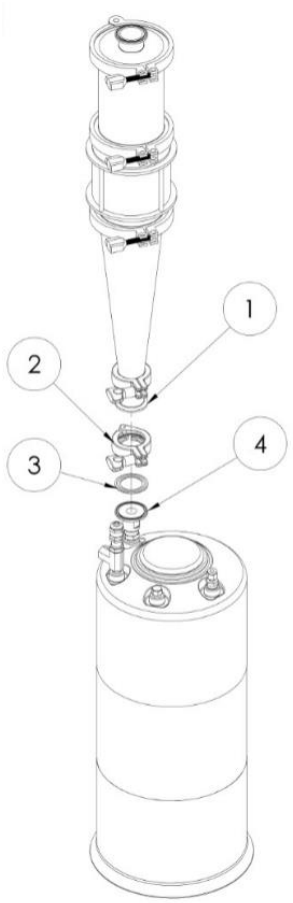

Figure 33. Figure showing the connection of the terpene collection (1) and the post collector.

Terpene Collection

The terpene collector catches terpenes and other plant volatiles that are not precipitated in the third collector at 800 psi. These include volatile terpenes, phenols, and various volatile organic matter. The terpene collector also catches any carryover of target product that may have not precipitated in the collectors. The terpene collector is comprised of a vessel that acts as an expansion chamber that allows the vapor to expand (4) resulting in the precipitation product. This chamber is typically 5 gallons but may be 2.5 gallons depending on the configuration that was ordered.

Recycler Operation

WARNING: Operating in recycle mode does not comply with GMP 21 CFR Part 177/176 design principals and increases the risk of concentrating toxic extractions products and cross contaminating them into new batches.

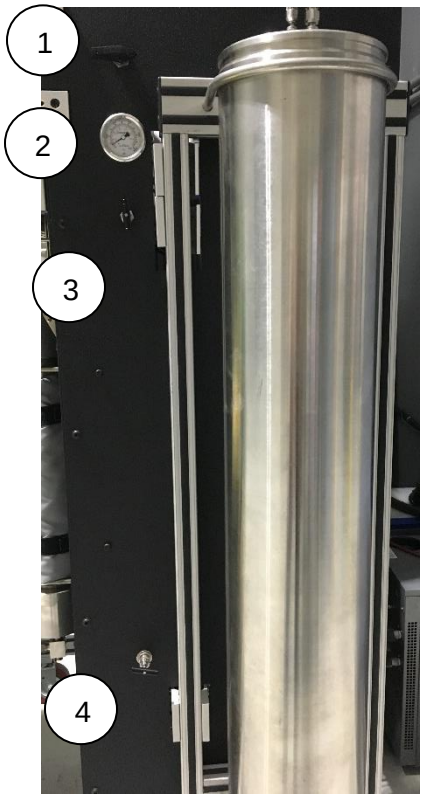

Figure 34. Recycler showing Fill Valve (1), Recycler Pressure Gauge (2), Top Vent (3) and Bottom Vent (4).

Overview

The recycler operates by providing a closed loop flow path that allows CO_2 to travel from the final collector to the inlet of the pump. This allows the system to greatly reduce overall CO_2 consumption at the expense of introducing the possibility of cross contamination.

The recycler tank serves as a reservoir of liquid CO_2 to feed the pump. Automated and manual valves control flow path and allow the recycler tank to be vented for maintenance.

Table 39. Component Description for Figure 34

Items	Location	Description
Fill Valve	1	Allows source CO_2 to fill recycler tank
Recycler Pressure Gauge	2	Displays pressure within recycler tank
Top Vent	3	Vent out of the top of the recycler tank
Bottom Vent	4	Vent out of the bottom of the recycler tank

Filling the Recycler

Before the recycler can be used, it must be filled with a supply of liquid CO2. It can be filled by the following procedure:

- Connect the extractor to source CO_2 via the inlet fitting.
- Ensure the extractor is powered on so the HMI recycler display can be noted.
- Open the inlet valve to introduce CO_2 to the extractor. The recycler tank will begin to fill, and the recycler display on the HMI panel will display the pounds of CO2 within the recycler tank.

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- During this process, the top vent valve can be slightly opened to speed the filling process. This will allow any air within the tank to escape as it is displaced by the liquid CO2.
- 25 lbs of CO_2 fills approximately 2/3 of the tank volume. This is sufficient to feed the pump. It can take 5-10 minutes to reach this capacity.
- Close the fill valve and the top vent valve.
- The recycler is now ready for use.

Using the Recycler

A critical component of the recycling system is the operation of Valve 8. If this valve is open, a flow path exists out to atmosphere and the system will not recycle. For the 1st run of the day, it is useful to keep Valve 8 open until the system is completely pressurized (BPR 1: 5000 psi, BPR 2: 2500 psi, BPR 3: 1250 psi, BPR 4: 800 psi.) This will push any existing air out of the system. Subsequent runs can be performed per normal procedures until the system is depressurized through collection.

Recycler Maintenance

Due to the principle of recycling the solvent, the possibility exists that soluble fats and waxes can travel through the flow path and be re-introduced into the pump. After running, these fats and waxes can precipitate out and create clogs in the system. Simple, daily maintenance can prevent the formation of these clogs. This can be done by the following procedure:

- Bypass the Recycler by using the orientation of bypass valves shown below:
- Open the inlet valve to Source CO_2.
- Open the black purge valve located on the pump (Extrakt 110 and Extrakt 110+) or just before the pump inlet (Extrakt 140). This will cause fresh CO2 to blow out from the valve.
- Purge the line for 10-15 minutes. If soluble fats and waxes are in the lines, white wax may be exit the lines.
- Close the purge valve and the inlet valve for Source CO_2. The system is now ready to sit idle.

Recycler Tank Cleaning

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Depending on the particular nature of a specific botanical and strain, extracted material may collect in the recycler tank. This material can be cleaned out be periodically by following the procedure below:

- Depressurize the recycler tank by opening the top and bottom vents on the recycler. Depending on the amount of CO_2 within the recycler, this venting process can take some time.
- Remove the two flexible hoses from the bottom of the recycler.
- Affix the lifter plate to the bottom cap nut using the included screws.
- Use the spanner wrench to remove the cap and cap nut.

WARNING: Ensure that the cap and cap nut are adequately supported during removal.

- Clean the cap and cap nut, collecting and cleaning any deposited oils, fats, and waxes from the cap, cap nut, and inside of the recycler tank.
- Ensure the feed tube is clear of any obstructions.
- Replace the recycler cap o-ring, apply a small amount of food-grade anti-seize, and re-install the cap and cap nut to the bottom of the recycler tank.

Routine Maintenance

Routine maintenance conducted by the operator on the instrument will ensure continuous operation and minimize costly and time-consuming emergency repairs. The following is a list of the intervals at which each system requires maintenance and the procedure to follow to complete the maintenance.

Users should establish and maintain a log book recording the extraction, extraction conditions and run time on the instrument. Users should also record when maintenance and calibration procedures are performed to keep track of when the procedures occur and when they are next due.

Maintenance Schedule

Routine Maintenance

Table 40. Table of Maintenance Schedule for Routine Maintenance

Procedure	Interval	PN
Upper Collector Seals	As required, at least 2x per week	80-0007
Lower Collector Seals	Every Removal	80-0007
Post collector Cleaning	Every Week	N/A
Terpene Collection Cleaning	As needed/every 2 weeks	N/A
Complete Tear Down	Every 1500 runs	N/A

Recycler Maintenance

Table 41. Table of Maintenance Schedule for Routine Maintenance

Procedure	Interval	PN
Purge Valve Cleaning	Daily, after production	N/A
Recycler Tank Cleaning	As needed/every 2 weeks	N/A

Scheduled Maintenance

Table 42. Maintenance Schedule Tables

MP-010
Pressure Transducer Calibration
Follow manufacturers recommendation

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MP-001
CO_2 and EtOH Pump Maintenance (Extrakt 110 and Extrakt 110+)

Procedure	Interval	PN	Procedure
Check Valve Replacement	6 months or 1000 hours	70-3201	MP-001
Aqueous Seal Kit	1000 hours/As Needed	70-3202	MP-001
Replace Pistons	As needed	880358	MP-001
Replace inlet/outlet filter	6 months or 1000 hours	70-3204	MP-001

MP-006
LEWA Pump Maintenance (Extrakt 140)

Item	Interval	PN	Procedures
Pump Diaphragm	Every 8800 hours	70-3305	MP-006
Hydraulic Oil	Every 8800 hours	Shell Morlina S2 BL 10 (Viscosity Grade, ISO VG 10)	MP-006
Gear Box Oil	Every 8800 hours	Mobil SHC 630 Gear Oil	MP-006

MP-004
Back Pressure Regulator Maintenance

Item	Interval	PN	Procedures
10000 psi regulator repair kit	1 x per month for first BPR, 1x per 500 runs for BPR 2,3,4	80-0004	MP-004, MM

MP-004
Chiller Maintenance

Item	Interval	PN	Procedure
Drain reservoir and refill	Every 6 months	N/A	MP-003, MM
Fan Filter cleaning	Every 6 months	N/A	MP-003, MM
In-line filter cleaning	Every 6 months	N/A	MP-003, MM

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Pressure Transfer/Venting Valve SS-3NRS4

Item	Interval	PN
Replacement Valves	Annually or as needed	80-1006

Maintenance Procedures

NOTICE: All breakers in main breaker panel must be in the off position before servicing.

WARNING: To prevent any electrical shock, before servicing, the system must be unplugged from the system.

NOTICE: Customer shall conform to any lockout-tagout procedure that may be applicable according to Customer's standard operating procedures

Rupture Disc Assembly Replacement

Rupture Assembly Components

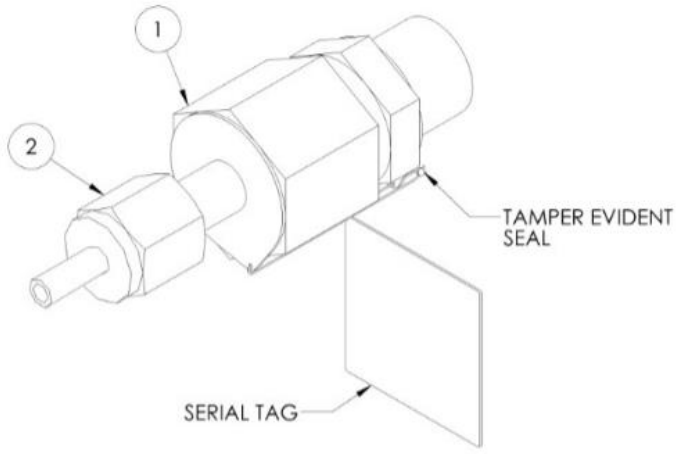

Figure 35. Rupture disc assembly.

Table 44. Components of Rupture Disc Assembly

Items	Location	Description
Disc Holder	1	Rupture discs are seals engaged in stainless steel holders and come from the factory pre-assembled.
Swage Connector	2	Easy Swagelok connection for fast replacement of assembly.
Serial Tag	3	Details the calibration and burst information for the disc.
Tamper Evident Seal	4	Tamper evident seal voids instrument warranty. The assembly is not user serviceable as it requires special torque tools.

Rupture Discs have been installed on this instrument as an over-pressure safety feature. They designed to rupture when the pressure in the extraction columns exceeds 6850 psi. The rupture discs are installed in the factory but if there is an over-pressure situation they will need to be replaced. When a safety rupture disc ruptures, the following will happen:

- You will hear a very loud noise.
- Leave the room, the instrument will shut off and interlock automatically
- CO_2 will begin to vent directly into the room
- The light tower will turn red and the CO_2 detector on board will shut off all pumps and valves within minutes.
- After the room has cleared so that the CO_2 concentration is less than 5000 ppm, you may reenter the room.

Root cause must be assessed before replacement of the rupture disc. Please see

Troubleshooting section of this manual. Once the system has been corrected, you will need to obtain a replacement burst disc assembly. Due to the high torque and specialized tools needed to seat the replaceable assembly, the assembly is not serviceable. You must take a replacement from your spare kit and exchange your broken disc by ordering a Zook service order from the server web store. To remove the assembly, follow this procedure:

- Make sure the system is completely vented.
- Remove the Zook assembly at the Swagelok nut.
- Use two wrenches (9/16” and 5/8”) to remove the assembly.
- Package and send to us.
- We will service the assembly and send it back to you in 4 weeks or less.
- Replace the burst disc assembly using the spare found in the Critical Spares Kit.
- Using the spare assembly, use two wrenches to replace the assembly.
- Follow WI-006 making and breaking connections to tighten the Swagelok fittings.

Functionality Test Procedure

- Turn chiller on and verify that the inlet temperature is less than 10^{o}C. The chillers function is to regulate the temperature of the incoming CO_2 and to cool the CO_2 pump heads.
- Turn the heaters on by pressing the "Heater off" button in the upper left corner of the touchscreen display. It will turn green and display "Heaters on". Each heater has its own control interface showing a SP value and a PV value. SP is the set point and PV is the temperature registered by the heaters internal thermocouple. Verify that heaters are set to the temperatures required for your extraction method. Allow heaters equilibrate for at least 30 minutes before performing an extraction.
- Before starting the CO_2 pump, ensure that all physical connections to and from the extraction column are sealed and that the extraction column vent valve is closed before starting the pump. See WI-006: Making and Breaking Connections for instructions on how to ensure proper sealing.
- In order to enable the pump to function, a flow path on the HMI panel must be established so the pump does not over pressure the system. Valves 1 and 3 control access to and exit from extractor 1. Valves 2 and 4 control access to and exit from extractor 2. Valve 5 allows flow to pass from the extractors to the first collector. Opening valves 1, 3 and 5 or 2, 4 and 5 will establish a flow path and grant access to pump control.
- After the system startup procedure has finished and the touchscreen schematic of the instrument is visible, confirm that the inlet valve on the side panel is open to allow CO_2 to flow from the cylinders to the pump. Check the pressure displayed on the CO_2 pump. The pressure in the tanks must be at least 750 psi and the tanks must be at room temperature (20°C) for the CO_2 delivered to the pump to be in the liquid state. If the CO_2

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tanks are not at room temperature, they must be allowed to equilibrate or they will not deliver liquid CO_2 to the pump. In general, it is best if the CO_2 tanks are allowed to equilibrate overnight at 20°C in the processing facility before use.

- With a flow path established, 2 buttons appear on the touch screen right below the heater control button. Press “pump off” to turn the pump on. The button will change from grey to green and read “pump on”. The CO_2 pump (Extrakt 110 and Extrakt 110+ only) has its own interface on the touch screen that allows the user to set flow rates and displays the pressure. Locate the pump interface on the left hand side of the screen, press it and enter the pump flow rate desired. The value entered must contain a digit after the decimal point to be accepted. This means that if you wish to run the pump at 300 mL/minute, a value of 300.0 must be entered into the interface.
- With a flow path established and the pump running, the user is allowed to have access to the preheated control. If there is no CO_2 flowing through the system, heater control is disabled. The preheaters sole function is to heat the liquid CO_2 after it leaves the pump. The set point of the heater should be such that it delivers CO_2 to the extractor at the same temperature as the temperature set point in the extractor. This is done so that the temperature of the material being extracted is uniform though out the extraction column.
- Complete functionality test procedure documentation CP-18.

Troubleshooting

Troubleshooting Concierge Service

At United Science, we have 24 hours, 7 days a week phone, email, and text troubleshooting service. Please call 651.464.2822, Ext 116 during office hours 8 am to 5 pm CST. For weekend and evening service, please call 651.538.1468. We stand behind our equipment and are fully dedicated to the best customer service experience and the highest quality extraction product in the industry.

Troubleshooting Overview

The top trouble spots for operating this equipment include:

1. Pump operation after CO_2 outrage or changeover.
2. Back pressure regulator 1 plugging.
3. Pump seals leaking.

In the following paragraphs, we go into detail on these areas and give prevention tips for each troubleshooting item.

Troubleshooting Pressure Problems Immediately Following a CO_2 Changeover

When the source of liquid CO_2 becomes depleted, the inlet pressure drops and the CO_2 liquid becomes vaporous. Vapor causes the pump to become vapor locked and unable to build pressure. The vapor must be removed from the pump head in order for the pump to function. *Ultimately, the best preventative action for this problem is to not run out of CO_2.* This is accomplished by feeding the extractor from a large vessel via a recirculation pump or a cylinder bundle as is commonly practiced in industry. Alternatively, if small (<100 lb) cylinders are being used, monitor the usage with a floor balance so that usage is easily measured.

Table 44. Potential Cause, Troubleshooting Procedure and Preventative Action for Pressure Problems Immediately Following a CO_2 Changeover

Symptom	Potential Cause	Troubleshooting Procedure	Preventative Action
Pressure not building	Vapor lock in pump.	Turn black pump purge valve counterclockwise for 3 minutes and let CO_2 vent	Monitor CO_2 usage with a floor balance so that CO_2 is monitored.

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		until pump head is cold. Turn on V1 or V2 to an extraction tank (filled with product) that is at atmospheric pressure. Liquid will siphon through the pump until the extractor pressure is at or around 850 psi. Then turn on the pump.	Eliminate changeover with sufficiently large CO_2 source.
Pressure not building	Pumping into an extractor vessel that is at a pressure of > 850 psi upon CO2 changeover.	Switch flow to extractor tank that is at low pressure (0 psi). Liquid will siphon through the pump until the extractor pressure is at or around 850 psi. After pressure starts to build in the extractor, you can switch back to the other extractor or continue to extract the second extractor. Alternatively, you can open all valves and extract both simultaneously until the run is done on the first tank. Simple calculations allow you to compensate for time remaining on each extraction column by	If equipped, open siphon valve. If not equipped, follow corrective procedure.

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		assuming that extraction time is directly proportional to flow rate.	
Pressure not building	Pump head is > 7ºC.	Turn on chiller, wait 5 min to cool down.	Make sure the chiller is on even during change over.
Preheater temperature is flashing red High Preheat Temp Alarm and will not maintain set point	Vapor lock in pump is causing a no flow. condition, so fluid is not flowing but preheater is on.	Turn black pump purge valve counterclockwise for 3 minutes and let CO_2 vent until pump head is cold.	Follow changeover instructions.

Checklist for CO_2 Changeover:
Is pump primed?
Is chiller on?

Troubleshooting Pump (Extrakt 110 and Extrakt 110+)

Maintenance on the pump must be scheduled after 1000 hours of use. Key failure modes include pump seals leaking, check valves leaking, and inability to build pressure. Failure modes are completely preventable with maintenance.

Table 45. Potential Cause, Troubleshooting Procedure and Preventative Action for Pump Problems

Symptom	Potential Cause	Troubleshooting Procedure	Preventative Action
CO_2 gas exiting from red plug (solvent wash) port on pump	Leaking CO_2 pump seal.	Once the leak is detected, you can finish your runs for the day and change out the seals at the end of the day.	Change pump seals at 1000 hours of use
Pump not building	Pre-filter is clogged.	Remove filter, clean, and	Inspect filter every

pressure even though pump is primed and CO_2 source is provisioned		replace filter.	week. Purchase quality CO_2 that is specified to be free of particulate matter.
Pump reaches max pressure and pump shuts off immediately	Valves closed. No flow path, V1 and V3, or V2 and V4, and V5 closed.	Open valve so there is a flow path.	
Pump not building pressure to set point on the first back pressure regulator	Pump not primed CO_2 source depleted Pump check valves are faulty. Possible cause could also be a leak. See leak troubleshooting. Possible cause could be a backpressure regulator pin seize.	Prime pump and fill CO_2 source. Inspect for leaks. How long since check valves were changed? If >1000 hours, change the check valves. If not, go to 4. Inspect backpressure regulator for pin seize.	
Pump reaches max pressure, all valves open, BPR1 pressure does not reach set point	Post pump filter is clogged.	Change pump filter as per MP-002.	Change as per preventative maintenance schedule at 1000 hrs.

Troubleshooting Pump (Extrakt 140)

Maintenance on the pump is primarily relegated to hydraulic and gear box oil every year. In the event of a rupture of the diaphragm pump head, the pressure gauge on the front of the pump head will display pressure.

Table 46. Potential Cause, Troubleshooting Procedure and Preventative Action for Pump Problems

Symptom	Potential Cause	Troubleshooting Procedure	Preventative Action
Pressure not building, pump is making intermittent clanking	Pump is being starved of CO2.	Ensure pre-filter is not clogged. Ensure CO_2 is adequate.	Inspect filter every week.
Pump not building pressure even though pump is primed and CO_2 source is provisioned	Pre-filter is clogged.	Remove filter, clean, and replace filter.	Inspect filter every week. Purchase quality CO_2 that is specified to be free of particulate matter.

Checklist for Pump Troubleshooting:
Do I have a flow path?
Is chiller on?
Is the pump primed?
Do I have a sufficient supply of CO_2?
Do I hear a hiss from the pistons?
Do I hear or see any leaks on the fittings throughout the system?
Have I cleaned the pre-filter in the last week?
How long has it been since I changed the check valves?

Troubleshooting Preheater

The preheater is essentially maintenance free and it is a very useful diagnostic tool. It will tell you if you have low or no flow of liquid CO_2. When the high temperature alarm triggers, it means you need to evaluate if you have enough CO_2. Also, the high temperature alarm is a good indicator of a vapor locked pump. The temperature at which the alarm triggers is set during installation at 75°C.

Table 47. Potential Cause, Troubleshooting Procedure and Preventative Action for Preheater Problems

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Symptom	Potential Cause	Troubleshooting Procedure	Preventative Action
Preheater will not turn on	Pump is not on.	Turn on pump.	
Preheater over temperature	CO_2 is low in tank.	Change CO_2 tanks.	Monitor CO_2 usage with a floor balance so that CO_2 is monitored. Eliminate changeover with sufficiently large CO_2 source.
Preheater over temperature	Pump is not primed properly and liquid is not flowing.	Turn black pump purge valve counterclockwise for 3 minutes and let CO_2 vent until pump head is cold. Turn on valve to an extraction tank (filled with product) that is at atmospheric pressure. Liquid will siphon through the pump until the extractor pressure is at or around 850 psi. Then turn on the pump.	Prime the pump.
Preheater over temperature	Pump is turned on, but flow is set at zero.	Turn set point of preheater to room temperature.	Be aware of method vs manual set points.
Preheater alarm is flashing intermittently but no priming or flow	Preheater set point temperature is to within 5°C of the alarm trigger.	Contact factory to change alarm set point.	

issues are apparent			

Checklist for Preheater:
Does the preheater set point in the method differ from what I manually set on the screen?
Is my set point greater than the alarm limit?
Do I have my pump flow rate set point at zero?
Do I have CO_2?
Did I just change the CO_2? Probably a vapor lock.

Troubleshooting Pressures

This portion of the guide is applicable for those who are confident that the CO_2 is in ample supply and that the pump is primed.
First step in any general pressure troubleshooting procedure is to verify that indeed the pneumatic valves (V1-V5) are opening and closing and are not stuck in either an on or off position. This can be accomplished by actuating the valves on the front HMI panel and then verifying the actuation by visual confirmation. Once that has been accomplished, then the guide below can help identify causes, troubleshooting procedures, and preventative actions.

Table 48. Potential Cause, Troubleshooting Procedure and Preventative Action for Pressure Problems

Symptom	Potential Cause	Troubleshooting Procedure	Preventative Action
Pump pressure reaches max and pump turns off	See pump troubleshooting guide.	See pump troubleshooting guide.	See pump troubleshooting guide.
Not able to build pressure quickly on extractor pressure gauge	Chiller is not turned on.	Turn on chiller.	
	Chiller not at temperature.	See chiller troubleshooting section.	
	Chiller tubing kinked so it is not cooling.	Unkink tubing.	
	Pump head temperature not cool enough.	Check chiller set point.	
	Faulty check valve in	See pump	

	Pump	maintenance.	
	Leaks.	Inspect for leaks.	
	Chiller not turned on in method.	Make sure manual and automatic operation match.	
Pressure too high in BPR 1 and in Extractor	BPR plugged.	Clean out BPR.	
Pressure at collector 3 > set point	Pressure or temperature too low.	Increase post heater temperature	
		Increase BPR 3 to 800 psi set point	

Checklist for General Pressure Troubleshooting:
Do I have a flow path?
Is chiller on?
Are my particles smaller than ten microns?
Has it been more than 100 hours since I changed the bag?
Is the pressure set point for collector 3 less than 800 psi?

Troubleshooting Leaks

There will always be minor leaks in a system that occur from time to time. Operators should be trained in making and breaking connections, changing seals, and servicing pump heads and seals before operating the system.

Table 49. Potential Cause, Troubleshooting Procedure and Preventative Action for Leaks

Symptom	Potential Cause	Troubleshooting Procedure	Preventative Action
Leak of CO_2 gas from top cap of collector	Leak in Buna seal.	Change O ring.	The upper seals on the collectors should be changed out at least once per week.

			The bottom seals should be changed out every time the vessel is opened to be cleaned.
Leak of CO_2 gas from top or bottom cap of extractor or collector	Leak in Buna seal.	Change O ring.	Buna o ring seals are 1x use.
Leak from fitting	Misalignment of tubing and fitting, fitting not tightened according to specifications.	Tighten finger tight plus ¼ turn.	Follow note WI-006 on making and breaking connections when loosening or tightening fittings.
Leak from bulkhead fitting	Fitting not tightened enough.	Tighten finger tight plus ¼ turn.	Follow note on making and breaking connections when loosening or tightening fittings.

Troubleshooting Leaky Valves

CO_2 leaks can occur from ball valves, needle valves, check valves, and back pressure regulator valves. Diagnosis of the leak is essentially very easy. You can detect a leak by the sound of a gas leak or by observation of oil leaking from the unit. In the case of a CO_2 leak, once the leak is located, you will notice that the gas has cooled down the valve.
Here are the steps to begin troubleshooting:

1. Turn off pumps.
2. Isolate the leaking valve by turning off all valves around the leaking valve.
3. If necessary, reduce the pressure in the collectors and extractors.
4. Follow instructions on removal and service of the specific valve in question.

Table 50. Potential Cause, Troubleshooting Procedure and Preventative Action for Leaky Valves

Symptom	Potential Cause	Troubleshooting Procedure	Preventative Action

Back pressure regulator will not regulate pressure	Clogged with plant matter.	See MP-004 for rebuild instructions.	Control particle size distribution.
Back pressure regulator will not regulate pressure	O-ring needs replacement.	See MP-004 for rebuild instructions.	Control particle size distribution.
Back pressure regulator will not regulate pressure	Seat seal is deformed from use.	See MP-004 for rebuild instructions.	Control particle size distribution.
Pump wont pump fluid even when CO_2 tanks are full and no vapor lock is present.	Check valves likely. However, see pump troubleshooting to diagnose.	See MP-002 for rebuild information	Execute maintenance schedule for pumps every 1000 hours.
CO_2 leaking from packing of ball or needle valves	Change packing as per protocol provided by factory.	See MP-007 for rebuild information.	Yearly inspection, change every year.
Ball valves not actuating	Contact factory.	Contact factory.	N/A

Troubleshooting the Chiller

The chiller needs occasional maintenance. Key failure modes related to the chiller include:

Table 51. Potential Cause, Troubleshooting Procedure and Preventative Action for Chiller Problems

Symptom	Potential Cause	Troubleshooting Procedure	Preventative Action
Chiller beeping	The chiller has moved so that there is a restriction in the chiller fluid.	Follow chiller manual.	
Chiller beeping	Chiller is low on fluid.	Follow chiller manual.	Follow maintenance

			schedule.
Temp not reaching set point; chiller beeping	Ambient temperature is too high or fan is blocked from airflow.	Follow chiller manual.	Ensure air flow is sufficient; service filter regularly.

Troubleshooting Erratic and Non Reproducible Pressure Changes from Method to Method Run in a Sequence

The sequence editor allows the customer to load multiple methods and run them in sequence. It is important that during any run, the chiller is turned on, the preheater is turned on, the vent is open, and the valves are properly programmed. Problems arise if methods in a sequence are not programmed properly. For example, if the chiller is operational on one run as per the method, and then in a subsequent run, the chiller is not operational as per the method, then the outcome will be radically different from method run to method run. Thus, it is imperative that if the customer is running many different kinds of methods in a sequence, that all the parameters that are required for that method are checked.

Troubleshooting Bags

The porous bags that are used to contain the ground plant matter have a finite lifetime. Typically, they will last for around 100-150 runs and then need replacing. Failure modes include small tears or vertical tears. When a bag breaks, particulate matter escapes from the bag and will make its way through the valves. This particulate matter will clog up the first back pressure regulator. Inspect the bag every time you use it for fatigue, frays or any signs of wear. If the bag is free from defects and the runs have not exceeded 100, then, in general, it is good to use again. Use with caution when the bag has been used more than 100 times.

Table 52. Potential Cause, Troubleshooting Procedure and Preventative Action for Bag Problems

Symptom	Potential Cause	Troubleshooting Procedure	Preventative Action
Green tinted extracts	Bag has broken or particles.	Replace bag.	Inspect bag for small tears prior to use, do not use bag for more than 100 hours.
Green looking extracts	Particles < 10 micron are	Measure particle	Get different grinder –

	eluting through the bag.	diameter distribution. Increase particle diameter.	better grinding is suggested; ideally grinding should produce 200um particles of consistent and uniformed size.
Particles in vent tubing, plant particles visible on the chiller.	Bag has broken during venting.	Replace bag.	Follow proper venting procedure as described in user manual.

Troubleshooting Run Away or Non-Responsive Heaters

Contact factory for troubleshooting guide.

Troubleshooting Fuses

If the heaters are not responding, then the circuit branch fuse may need to be changed. Fuses are located in the control box. Contact factory if you suspect a faulty fuse.

Troubleshooting Load Center Breaker

If the load center breaker is tripped, contact the Factory immediately.

Troubleshooting Collector

Table 53. Potential Cause, Troubleshooting Procedure and Preventative Action for Collector Problems

Symptom	Potential Cause	Troubleshooting Procedure
Flexible tubing freezes during collection	Dry Ice formation in collector.	Apply heat gun to flexible tubing while collecting.
Flexible tubing freezes during collection	Dry Ice formation in collector.	Increase temperature in collector at touchscreen.
Flexible tubing freezes during collection	Dry Ice formation in collector.	Increase rate of collection by opening vent valve more rapidly.

Pressure at BPR for Collector 3 begins rising	Obstructed flow path at or after BPR for Collector 3 from frozen tubing.	Turn Post heater on or increase temperature in post heater.
Pressure reading at BPR 1 drops to same pressure as BPR 2 during vent cycle or whenever valve 5 is closed	BPR1 is clogged.	Collect product, vent entire system and perform MP-001 Back pressure rebuild procedure.
BPR 1 will not build pressure	BPR 1 is clogged.	Collect product, vent entire system and perform MP-001 Back pressure rebuild procedure. Remove stainless tubing between valve 5 and BPR1. Sonicate in EtOH to clean.
Collection Vessel Troubleshooting		
Flexible transfer line clogs	Product is freezing in line as a result of CO2 expansion.	Use heat gun on flexible line to prevent it from freezing during collection. Collector heater temperature can also be increased.
Dissolved product emitting from Collection tank PVC vent tubes	Venting too quickly.	Close Collector valve slightly.

Specifications

General Operating Characteristics

Table 54. Table for General Operating Characteristics

Attribute	Specifications
Flow Rates range (LPM)	0 to 1.5 L/min
Max Operating Pressure (psi)	5,000 psi
Operating Temperature (°C)	15 to 30°C
Eluent inlet lines	Up to 2
CO2 Solvent inlet lines	1
Sound Pressure	40 db
User Interface	Touch screen HMI panel

Process Utilities Requirements

Table 55. Table for Process Utilities Requirements

Process Utilities Requirements				
TYPE	**QUALITY**	**CAPACITY**	**PRESSURE**	**TEMPERATURE**
Compressed Air	Class IV 40 µm filtered, oil free,	0.33 Nm^3/h	80 psi	Room
Solvent	Food grade or better 2 µm Filtered, degassed	36 mL/min max	N/A	5°C to 60°C
Carbon Dioxide, Liquid	2 µm Filtered, 850 psi, food grade or better	300-600 mL/min	850 psi inlet	20-30°C
Thermo Fluid	Clean	1 m^3/h max	6 bar max 0,7 bar @ 1 m^3/h	2°C to 90 °C

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Environmental Specifications

Table 56. Table for Environmental Specifications

Attribute	Specification
Operating Temperature	5 to 40°C (15 to 30°C is optimal)
Operating Humidity	20 to 80%
Transportation and Storage Temperature	-20 to 60°C
Transportation and Storage Humidity	<60%
Environment	Approved for indoor use
Altitude	Approved for use up to 2000m
Sound Pressure	45-50 db
Pollution Degree	2

Electrical Specifications

Table 57. Table for Electrical Specifications

Attribute	Specifications
Models	Up to 1500 mL/min, 10,000 psi Max Pressure
Full Load Amps	47 FLA (Extrakt 110) 57 FLA (Extrakt 110+) 67 FLA (Extrakt 140)
Voltage	240 VAC
Phases	Single phase (Extrakt 110, Extrakt 110+) Three Phase (Extrakt 140)
Frequency	60 Hz

SCCR	10 kVA
Enclosure Ingress Protection	NEMA 1, Tools required
Electrical Input Connection	Customer shall provide electrical connections according to installation specifications.
Line Voltages, nominal	Grounded AC
Protection class	Class I
Overvoltage category	II
Pollution degree	2

The size and overcurrent protection of the supply conductors to machine shall be covered by Article 670 of NFPA 70.

Venting Specifications

Table 58. Table for Venting Specifications

Attribute	Specifications
On board venting (front)	Manual damper controlled vent for direct exhaust of collection gasses
Extractor Column venting	Venturi damper controlled onboard vent for direct exhaust of extractor gasses
Venting connection	600-2000 cfm vent fan, earth grounded 2” cmp pipe
Anti-Static Piping	Conductive, Antistatic, carbon steel
Grounding	Earth ground required
Wetted Materials	Carbon Steel, Anti Static Poly Propylene

Chemical Compatibility	Gasses, polar solvents, no acids or bases

Extractor Vessels

Extractor vessels are held at a high temperature and pressure to dissolve oils from biomass. Oils that are locked in the biomass are dissolved in liquid CO2 as they become solvated as a function of temperature and pressure.

Table 59. Table for Extractor Vessel Specifications

Attribute	Specifications
Extractor Volumes	5, 20 L
Extractors per System	2
Maximum Allowable Working Pressure (psi)	6800 psi
Wetted Materials	304 SS, Buna-n
Chemical Compatibility	CO2, Organic Solvents, Acids and Bases, plant extracts
Temperature Control Range	25 to 100°C
Compliancy	Independently P.E. Stamped according to ASME DIV II VII-2

Collector Vessels

Extracted oils that are dissolved in the solvent are fluidically conveyed to collector vessels that are held at user defined temperatures and pressures to accomplish selective precipitation of the dissolved product.

Table 60. Table for Collector Vessel Specifications

Attribute	Specifications
Collector Volumes	2.5, 5 L
Collectors per System	3
Maximum Allowable Working Pressure (psi)	8500 psi
Wetted Materials	304 SS, Buna-n
Chemical Compatibility	CO_2, Organic Solvents, Acids and Bases, plant extracts
Temperature Control Range	25-100ºC (600 w)
Cooling	Optional Internal Cooling Coil (1500 watts)
Compliancy	Independently P.E. Stamped according to ASME VIII DIV 2

Valves

Table 61. Table for Valve Specifications

Attribute	Specifications
Valves	Ball valves, check valves, back pressure regulators
Construction	Stainless Steel, medium pressure fittings throughout
Compliancy	ASME VII DIV II
Actuation and Automation	Pneumatic
Wetted Materials	PEEK, PTFE, 304 Stainless Steel
Chemical Compatibility	CO_2, Organic Solvents, Acids and Bases, plant extracts

Allowable Temperature Range	up to 100°C
Maximum Pressure	7500-10,000 psi

Heat Exchangers

Table 62. Table for Heat Exchanger Specifications

Attribute	Specifications
Tube in Tube	Tube in tube
Wetted Materials	316 Stainless Steel, medium pressure fittings throughout
Max Pressure	4000 psi at 100°C
Fluid Exchange Media	Water at 5°C or 50% glycol at -5°C
Capability	1200 W
Chemical Compatibility	CO2, Organic Solvents, Acids and Bases, plant extracts
Allowable Temperature Range	-20°C to 150°C

Pumps

Table 63. Table for Pump Specifications

Attribute	Specifications
CO_2 Pump	Chilled heads, Up to 3000 mL/min, 10,000 psi Max Pressure
Cleaning Pump	Optional, up to 150 mL/min, 5000 psi Max Pressure

Process Aid Pump	Optional, up to 150 mL/min, 5000 psi Max Pressure
Co-solvent Pump	Optional, up to 150 mL/min, 5000 psi Max Pressure
Wetted Materials	Sapphire, PTFE, 316 SS
Prechiller	3500 W @ -5°C
Pre filter	40 microns, 316 SS construction, 4000 psi max pressure
Chemical Compatibility	CO_2, organic solvents, acids and bases, plant extracts

CO_2 Specification

Table 64. Table for CO_2 Specifications

Attribute	Specifications
CO_2 Minimum Inlet Pressure	750 psi,
CO_2 Purity	Conforming to CFR, EIGA, CGA regulations for food grade 99% Pure CO_2
CO_2 Bottle Source	Dip tube required, 60L CGA 320
Cylinder Bundles	Available for up to 16-60L 320 CGA cylinders that are pre plumbed for convenience.

6 Ton Bulk Storage	Available with recirculation pump for GMP installations

Temperature Control Modules

Table 65. Table for Temperature Control Module Specifications

Attribute	Specifications
Pre Heater	Max Temp, 140°C, K type thermocouple, PID Control Algorithm, Wetted Materials: 316 SS, 10000 PSI MWAP, NEMA 1 Enclosure, Direct wire Max pressure: 10,000 PSI
Vessel Heaters	Max Temp, 100°C, K type thermocouple, PID Control Algorithm, insulated blanket heaters
Collector Heaters	Max Temp, 100°C, K type thermocouple, PID Control Algorithm, insulated blanket heaters
Post Heater	Max Temp, 140°C, K type thermocouple, PID Control Algorithm, Wetted Materials: 316 SS, 10000 PSI MWAP, NEMA 1 Enclosure, Direct wire Max pressure: 10,000 PSI
Zones	Up to 16 zones, independent control

Insulation

Table 66. Table for Insulation Specifications

Attribute	Specifications
Fire Rating	Certificate, 200°C max
Materials	3170 Grey Silicone Cloth
R Value	5 Gage Insulation, 10

Safety

Table 67. Table for Safety Specifications

Attribute	Specifications
Rupture Discs	Zook burst discs, calibrated, ASME VIII Div II compliant, Max Pressure is 6850 psi, Certificate Attached to Disc
Temperature Switch	Preheater, Post heater MAX TEMP 140 pC, Certificate Available Collector, Extractors MAX TEMP 100°C, Certificate Available
E-stop Switch	Switch disengages main contactor
CO2 Gas Detector	Built in alarm, turns off pump and closes valves at 9000 ppm, Certificate Available
Interlocks	Marked with safety warnings

Pressure Transducers	Post pump, Extractor, Collector 1,3; Turns off pump when overpressure (>5800 psi) condition is detected.
Isolation Valves	Manual

Containment System

Table 68. Table for Containment System Specifications

Attribute	Specifications
Max Pressure	MAWP 300 psi
Poppet Valve	200 psi max
Wetted Materials	Buna-N, 316 SS
Surface Finish	16 micro in or better
Temperature Range	-50°C to 100°C
Rigid connection hose	3000 psi max pressure

Seal Material	Buna-n

Recycler

Table 69. Table for Recycler Specifications

Attribute	Specifications
Max Pressure	6800 psi, MAWP, CRN Number Available
Rupture Disc	2500 psi, Certificate
Filter Elements	200 micron 100 micron
Heat Exchanger	2400 W
External Chiller	3500 W, Certificate
Wetted Materials	Buna-N, 316 SS
Temperature Range	-50°C to 100°C

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Flexible connection hose	3000 psi max pressure
Seal Material	Buna-n

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Customer Interface

Table 70. Table for Customer Interface

Item	Description	Visual
CO_2 Feed	1/8” compression fitting type Swagelok® Follow WI-006 and manufacturer’s documentation for making and breaking connections.	
Compressed Gas	ColorConnex Push-To-Connect female Green Coupler, ARO Type B 1/4 in. FNPT	
Ventilation Interface	Customer shall provide a vent fan that will provide a minimum of 1000 CFM and vent fan conduit that is antistatic and can interface with a 2” EMT Pipe as per the requirements listed in the installation section.	
Electrical Interface	Customer shall provide electrical connections according to installation specifications	

Other Characteristics

Table 71. Table for Other Characteristics

Attribute	Specifications
Tubing internal roughness	< 0.8 µm Ra (32 µ-inches Ra)
Valves internal roughness	< 2.4 µm Ra (94 µ-inches Ra)
Material wetted parts	Stainless Steel 316, Stainless Steel 304, Quartz, PTFE, PFA, PEEK, Urethane
Frame	Aluminum, anodized Bonded joints
Electrical cabinet	Painted Steel
Electrical design	Designed for general purpose area
Air Quality	Class 1V or better

Automation

Architecture of the Control

Table 72. Table for Architecture of the Control

Architecture of the Control	
Operator Interface	A touch screen graphical user interface is used for the operator interface and historical data logging through the automation software. This automation software provides automated and safe operation of the solvent pumping module.
PLC Controller	A Programmable Logic Controller (Click PLC from Koyo) ensures real-time operation, high availability (reliability) and a high degree of safety. The communication between the PLC and the operator interface is based on Ethernet protocol.
Electrical cabinet	It is a box which contains all controls and electrical components necessary for proper operation of the system (power supplies, fuses, PLC I/O cards, PLC controller).
Telemetry Option	Remote monitoring and datalogging software allows remote troubleshooting, service, software and firmware updates.

Description of the Software

Table 73. Table for Description of the Software

Description of the Software	
User Access	The User Access Module is used to define access rights of the users for the protection of the system. The password and Username strategy are managed by the operating system.
Datalogging Module	The Datalogging Module is used for logging and viewing the data acquired during the system operation.
Graphics	It allows to trend relevant process parameters such as CO_2 signals, flowrate, pressure drop, temperature, etc. It also allows the user to compare data from various cycles within a run..
Method Editor	The Recipe Editor module is used to create easily and quickly the base parameters of the method (Recipe Identification, Recipe Duration, Valve Configuration).
Manual Mode	The Manual Module is typically used for the priming and testing.
Sequence Mode	The Sequence Mode runs extraction in an attended mode as defined in the Method. Methods may be linked. For example, the user can run five cycles of a given separation method and then run one cycle of a regeneration method and then run again five cycles of the separation method.
Alarms	The alarm data and event data are stored as an event in the batch record. This data can be recalled from batch management module.

Reserved Parameters	This module has restricted user access. It contains all critical parameters, which could affect safety, validation or operation of the unit.

Automation Interface

Table 74. Table for Automation Interface

Action	Type
Pump Power off and process stop	Digital input dry contact (DI)
Full functional remote access	Ethernet, WIFI, Customer Computer
Status of the (RUN or STOP)	Digital output dry contact (DO)

Weight & Dimensions

Table 75. Table for Weight and Dimensions

Weight and Dimensions	
2000 lbs (Extrakt 110 and 110+)	88” x 34” x 76”
3600 lbs (Extrakt 140)	88” x 34” x 76”

Delivered Documentation

Table 76. List of Delivered Documentation

Documentation
User Manual with maintenance and troubleshooting instructions Spare Parts List – Online shopping Packing List for Start-up Kit
Piping & Instrument Diagram (P&ID) Process Parts List (PPL) Manufacturer technical documentation for process components Calibration certificates for process instruments
General Drawing Material conformity certificates of the mechanical parts in contact with the process fluid
Electrical cabinet Wiring diagram
Hardware Design Specification (HDS) Functional specification (FS)
Manufacturers declaration for NFPA 79 Compliance
FAT Protocol FAT results and report SAT Protocol SAT results and report

United Science Quality Plan

Table 77. Table for United Science Quality Plan

Item	Description
Manufacturing Tests	United Science Equipment is fully tested during the Manufacturing Acceptance Test. The equipment has been manufactured following United Science Process's design documentation. The manufactured equipment is operating within the specified tolerances. Manufacturing Tests are integrated into our ISO compliant quality system.
Customer Factory Tests	Customer Factory Acceptance test (FAT) and Site Acceptance Test (SAT) are available upon request. Only tests due to dismounting (for transportation purposes) or tests where the customer's environment has an impact on the equipment settings are reproduced during SAT.
Examples of Tests applied (not limited)	Check that the manufactured equipment is compliant with the United Science engineering documents: P&ID, Mechanical Drawing, Electrical Drawings. Check of the instrumentation calibration, Check of the safety devices (emergency stops and relief valves), Check of the critical functions. To get a fully detailed list of applied tests, please refer to the FAT & SAT protocols which are available upon request.

Warranty Information

Disclaimers and Limited Warranty

1. No warranty coverage shall be afforded CUSTOMER without signed installation and operational qualification documentation certifying adherence to installation specifications. Signed documentation shall be delivered to UNITED SCIENCE within 10 days of FAT testing.
2. UNITED SCIENCE warrants to CUSTOMER (i.e., the original purchaser of Equipment) that for the Warranty Period (as defined below), the Equipment will be free from material defects (except as noted below) in materials and workmanship. The foregoing warranty is subject to the proper installation, operation and maintenance of the Equipment by CUSTOMER in accordance with installation instructions and the operating manual supplied to CUSTOMER. Warranty claims must be made by CUSTOMER in writing within ten (10) days of the manifestation of a problem. If CUSTOMER submits a warranty claim and UNITED SCIENCE determines that such claim is not due to a material defect in materials or workmanship, CUSTOMER shall be responsible for paying UNITED SCIENCE its standard rates and fees (as well as any shipping and travel expenses) associated with UNITED SCIENCE responding to such claim.
3. The "Warranty Period" begins on the date the Equipment is delivered to the common carrier and continues for twelve (12) months.
4. Any repairs under this warranty must be conducted by an authorized UNITED SCIENCE service representative. If warranty replacement parts are ordered, they will be shipped via normal ground transportation. Any expedited forms of shipment will be at the CUSTOMER’s expense.
5. Excluded from the warranty are problems due to accidents, misuse, misapplication, storage damage, negligence, electrical surges, improper grounding, voltage fluctuations, or modification to the Equipment or its components. All maintenance (other than warranty repairs) and the cost of all consumables to be used with the Equipment shall be at CUSTOMER’s sole expense. Certain third party portions of the Equipment may be covered by a separate written warranty from the manufacturer of such portion, which warranty may be passed through to CUSTOMER if permitted by the original warrantor.
6. UNITED SCIENCE does not authorize any person or party to assume or create for it any other obligation or liability in connection with the Equipment except as set forth herein.

Limitation of Liability.

IN NO EVENT SHALL UNITED SCIENCE BE LIABLE FOR ANY INDIRECT, INCIDENTAL, PUNITIVE, SPECIAL OR CONSEQUENTIAL DAMAGES, OR DAMAGES FOR LOSS OF PROFITS, REVENUE, OR USE INCURRED BY CUSTOMER OR ANY THIRD PARTY, ARISING IN CONNECTION WITH THIS AGREEMENT OR WITH THE USE OF OR INABILITY TO USE THE EQUIPMENT FURNISHED UNDER THIS AGREEMENT, WHETHER IN AN ACTION IN CONTRACT, OR TORT, OR OTHERWISE EVEN IF ADVISED OF THE POSSIBILITY OF SUCH DAMAGES. UNITED SCIENCE'S AGGREGATE LIABILITY FOR DAMAGES ARISING OUT OF OR IN CONNECTION WITH THIS AGREEMENT OR THE EQUIPMENT SHALL IN NO EVENT EXCEED THE PURCHASE PRICE OF THE EQUIPMENT RECEIVED BY UNITED SCIENCE HEREUNDER. THE PROVISIONS OF THIS AGREEMENT ALLOCATE THE RISKS BETWEEN UNITED SCIENCE AND CUSTOMER. UNITED SCIENCE'S PRICING REFLECTS

THIS ALLOCATION OF RISK AND BUT FOR THIS ALLOCATION AND LIMITATION OF LIABILITY, UNITED SCIENCE WOULD NOT HAVE ENTERED INTO THIS AGREEMENT.

THE EXPRESS WARRANTY IN SECTION 7(a) ABOVE IS EXCLUSIVE AND IN LIEU OF ALL OTHER INDEMNITIES OR WARRANTIES, WHETHER EXPRESS OR IMPLIED, INCLUDING WITHOUT LIMITATION ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE, AND IS IN LIEU OF ANY AND ALL OTHER OBLIGATIONS OR LIABILITY ON UNITED SCIENCE'S PART. NOTWITHSTANDING ANY APPLICABLE LAW TO THE CONTRARY, THE PARTIES EXPRESSLY AGREE THAT UNITED SCIENCE'S MAXIMUM LIABILITY FOR BREACH OF SUCH EXPRESS WARRANTY SHALL NOT EXCEED, AND CUSTOMER'S SOLE REMEDY IS EXPRESSLY LIMITED TO, EITHER (AT UNITED SCIENCE'S SOLE OPTION): (i) REPAIR OR REPLACEMENT OF THE DEFECTIVE PART OR EQUIPMENT, OR (ii) RETURN OF THE EQUIPMENT AND REFUND OF THE PURCHSE PRICE; AND SUCH REMEDY SHALL BE CUSTOMER'S ENTIRE AND EXCLUSIVE REMEDY

Appendix

Spare Parts List

Table 78. List of Spare Parts

Quantity	Item	P/N
	Critical Spares Kit, Extrakt 110, 110+	10-1000
1	Check Valves for CO2 Pump, 4/Pack	70-3201
4	Aqueous Seal Kit for CO2 Pump	70-3202
1	Outlet Filter for CO2 Pump, 2/Pack	70-3204
2	Rebuild Kit for 10,000 psi Back Pressure Regulator	80-0004
1	Spare PEEK Seat	80-4613
1	Spare Zook Burst Assembly	80-0022
1	¼" Swagelok Ball Valve	80-2125
1	Bags, 5L	70-1057
2	122 Cast Urethane O-Ring	80-4609
2	012 Cast Urethane O-Ring	80-4612
1	5A Fuse	80-6050
1	10A Fuse	80-6051
1	3A Fuse	80-6052
	Spare Parts for Solvent Pump Kit, 10-1001	10-1001
1	Check Valve Kit for Solvent Pump	70-3102
1	Aqueous Seal Kit for Solvent Pump	70-3101
1	Inlet Filter Kit for Solvent Pump	79-3104

1	Outlet Filter for Solvent Pump	70-3103
	Spare Parts for CO2 Pump Kit, 10-1002	10-1002
1	Check Valves for CO2 Pump, 4/Pack	70-3210
2	Aqueous Seal Kit for CO2 Pump	70-3202
1	Outlet Filter for CO2 Pump, 2/Pack	70-3204
4	Inlet and Outlet Screens for Extractors	80-0115
1	Buna Seals for Containment Systems, Seal Kit	10-1003
1	Buna Seals for Terpene Collector System, Kit	10-1004
1	25 packs of 3" o-rings	80-0007

Installation Kit Contents

Table 79. Contents of Installation Kit

Quantity	Item	P/N
	Extractors and Collectors	
1	1-3/4"' wrench	50-0108
1	1-1/8" wrench	50-0083
2	25 packs of 3" o-rings	80-0007
1	Food Grade Anti-sieze	80-0008
1	Spanner wrench	50-0048
	Product Addition Kit	10-1008
1	Stainless Funnel	80-9011
1	3-1/2" to 2-3/8" pvc adapter	50-0109
1	Product Scoop	80-9012
4	5L bags	70-1057
4	10L bags	70-1058
	CO2 hook-up for 6 ganged tanks	
1	6 tank plumbing assembly with CGA 320 nut and 8' of 1/4" flex connection tubing.	10-1010
	Cleaning Kit	10-1011
1	3" tube brush	80-9022
1	1" tube brush	80-9023
1	1/4" tube brush	80-9024

1	small spatula set	80-9015
1	spoonula	80-9016
1	spray bottle	80-9013
1	10L sonicator	80-4004
	Electrical	10-1013
1	Power Cord Adaptor	80-6036
1	Ethernet to USB Adaptor	80-6039
1	Ethernet cord	80-6028
	PPE Kit	10-1014
1	face shield	80-0059
	Ethanol Pump Kit (optional)	10-1013
1	FEP tubing inlet	70-3112
1	Bottle, Schott, 1L, Hole in top	70-3108
1	Plastic Syringe	70-3111
	Documentation Kit	10-1016
1	CGA Manual	80-9027
1	Operators Manual	80-9026
1	Maintenance & Cleaning Procedures	80-9028
1	FAT Documentation	80-9029
1	Packing Slip	80-9031
1	Site Readiness Documentation	80-9030

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