WARNING

FAILURE TO FOLLOW THE SETUP AND OPERATION PROCEDURE PROVIDED IN WITHIN THIS MANUAL MAY VOID THE EXTRACTION SYSTEM’S WARRANTY

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1. Critical Safety Overview

Throughout these instructions, this symbol is used to indicate that the instructions are critically important to your safety and the safety of your system. Failure to follow the instructions as written can result in a rapid release of high pressure CO\textsubscript{2} potentially causing equipment or personnel damage.

![WARNING]

Subcritical and Supercritical CO\textsubscript{2} systems operate under high pressure. Operators must be fully trained and familiar with the system. Failure to operate the system can result in equipment damage and/or bodily injury.

![WARNING]

Subcritical and Supercritical CO\textsubscript{2} systems use large amounts of CO\textsubscript{2} during operation. Ensure that system is installed in a well-ventilated area to prevent buildup of CO\textsubscript{2} which can cause asphyxiation. Use of a CO\textsubscript{2} monitor is strongly recommended.

![WARNING]

Opening a vessel under pressure can result in a rapid release of pressure and ejection of the material inside the vessel. **DO NOT ATTEMPT TO OPEN A VESSEL UNDER PRESSURE!** Always make sure a vent path for the vessel is opened and the corresponding pressure gage reads zero prior to loosening the vessel hammer unions.

![WARNING]

Subcritical and Supercritical CO\textsubscript{2} systems are designed to operate indoors. Extreme temperatures (below 60°F and above 80°F) will negatively impact the functionality of the system. The environmental temperature range is for the system, chiller, pump and CO\textsubscript{2} bottles.

![WARNING]

Only use Propylene Glycol and distilled water in the chiller and cooling system. Never use Deionized Water in the chiller or cooling system.
2. System Operation

The following operating instructions are for the Apeks 2000 psi CO₂-based Botanical Oil Extraction systems. Instructions manuals for the Thermo-Fisher chiller and Diaphragm Compressor are supplied separately. Failure to follow the instructions provided below may void the warranty of the extraction system and its components.

2.1. 2000 System Overview

2.2. Automation Overview

2.2.1. The Human Machine Interface (HMI) is a 10-inch color touch screen. Almost all of the inputs, outputs and human/machine interactions are managed through the HMI. The features are not controlled or reported through the Diaphragm Compressor or the Chiller.

2.2.2. The HMI has two functions; 1) to provide information and 2) to accept inputs from the operator. Description of some of the interaction is here:

2.2.2.1. If a display value or message is colored orange, an operator must take action before progressing forward.

Figure 1. System Components

NOTE: Alternate system setup shown for clarity, setup type can be requested at time of order, additional cost may apply

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2.2.1.1. Orange indicates that an operator activity is required before the Start button can be depressed. Messages highlighted orange are indicative of a scheduled maintenance interval being reached.

2.2.2. Red messages indicate that a component of the system has either failed to reach the minimum operating pressures or temperatures, or that it exceeded the programmed operating limits. Red messages are typically reserved for alarms that could potentially shut down the machine if the condition causing the alarm is not returned to normal.

2.2.2.1. Red messages may require user acknowledgement or may simply disappear when an abnormal condition returns to normal parameters. If there is a button that appears, user intervention will be required.

2.2.2.3. Yellow messages will typically be displayed on a button that has to be pressed to acknowledge that the operator has read the message before it will disappear.

2.2.3. Any variable or message that needs to be (or can be) controlled by the operator are graphically raised to illustrate that the “message” is a button. An example of the different graphical representations is shown below.

![Figure 2. Indicator vs. Button](image)

2.2.4. The controller has safety interlocks programmed into it. These safety interlocks prevent unsafe operations from occurring by monitoring the system parameters and by removing unsafe action/input control buttons from the HMI. When buttons appear to be missing from the home screen, it is because the system is performing an operation that would be unsafe in combination with the missing button/action.

2.2.5. The HMI will provide message popups (in yellow boxes) to instruct the operator what steps are required next in order in to complete any action selected. Most message popups are also acknowledgement buttons that must be pressed before any further action can be taken.

2.2.6. The primary operating valves on the Apeks system are air actuated valves controlled by the systems controller. In the event of an air compressor failure or a power failure all air actuated valves will return to their normal resting state. Valves 0 and 17B will be normally open and all others will be closed.

2.2.7. Each air actuated valve has an indicator on the top to inform the operator which valves are open and which ones are closed. The indicator lines correspond with the flow direction. The following figure illustrates both and open and closed valve. Note that it does not matter which way the air actuator is oriented, rather the direction of CO₂ flow is important.
2.3. Pre-Cleaning

2.3.1. The Apeks system is constructed from 304 and 316 stainless steel and can be cleaned with any cleaner that is compatible with both stainless steel and your extracted product. Alcohol (200 proof) works well for most applications.

2.3.2. The system should be cleaned to the appropriate level (determined by your application and corresponding regulations) prior to processing each batch of botanical material.

2.3.2.1. Apeks takes great care to clean all systems prior to shipping, however, it is the user’s responsibility to ensure that the system meets their required level of cleanliness before processing material.

2.4. Depressurizing System after Recovery

2.4.1. After completion of recovery, Valve 4 (4A and 4B for dual vessel) will open to relieve residual extractor pressure. A yellow acknowledge button will appear in the home screen.

2.4.2. Follow directions in order:

2.4.2.1. Close (turn clockwise) CO2 Bottle(s)

2.4.2.2. Open Valve 10 to relieve separator pressure

2.4.2.3. Press acknowledge box, this will relieve the pressure in the CO2 bottle lines and the rest of the system.

2.4.3. Open all manual valves.

2.4.4. Turn off the chiller/heater.

2.4.5. NOTE: any time the diaphragm pump stops the system will automatically vent CO2 from valve 0 in order to relieve stress on the diaphragm head.

2.4.6. If system was stopped unexpectedly and system needs recovered proceed to the “Manual Screen” to recover CO2 and then follow steps 1 thru 5.

2.5. Removing Oil from Separator #1

**WARNING**

DO NOT ATTEMPT TO OPEN A VESSEL UNDER PRESSURE! Always make sure a vent path for the vessel is opened and the corresponding pressure gauge(s) reads zero prior to loosening the vessel closure bolts.

2.5.1. Ensure Valve 10 is open

2.5.2. Ensure that the all three gauges on separator vessels (shown below) and separator pressure on the home screen reads zero.
2.5.3. Remove the flexible metal line and connection pipe from the top of the separators. Use two wrenches to prevent the bending tubes or NPT fittings from loosening in the separator cap.

2.5.4. Remove the yellow wire connected to the Separator #1 thermocouple.
2.5.5. Remove the white vent tube attached to the pressure relief.
2.5.6. Use the 5/8-in ratchet wrench to remove the high pressure sanitary clamps from the top of Separator #1.
2.5.7. Remove the cap from the top of separator.
2.5.8. Collect any available oil from the separator cap.
2.5.9. Use alcohol to clean the caps and orifice tube.
2.5.10. Use the supplied round squeegee or hard plastic scrapper to push any residual oil from the sides of the Separator #1 down to the bottom and in the collector cup.

2.5.11. Disconnect the two blue water line quick connects on the collection cup.

2.5.12. Attach the collector cup quick connects together and attach the bottom separator 1 quick connect to the heat exchanger quick connect. This will ensure water flow even if collector cup connections are not re-attached in assembly.

2.5.12.1. Caution if removing the cup in the middle of a run with the pump on this step must be followed or the system may automatically shut down due to lack of water flow.

2.5.13. Use caution to support and not to drop the collector cup, remove the high pressure sanitary clamps from the bottom of the separator 1 with 5/8-in ratchet wrench.

2.5.14. Remove the collection cup from Separator #1.

2.5.15. Collect the oil from inside the collection cup.

2.5.15.1. Note: Oil will be carbonated with CO2 and some dry ice may be present. This carbonation or dry ice will sublime without any additional heat. It is sometimes more efficient to remove the dry ice/oil mixture and place it in collection device (like a Pyrex dish).

![Image of collection cup after removal from separator.](image)

2.5.16. Use the round squeegee and alcohol to thoroughly clean the inside of the separator and collection cup.

2.5.17. Separator #1 and the collection cup must be cleaned after each extraction.

2.5.18. Reassemble separator #1 by reversing the steps above, excluding the connection piping from Separator #1 to #2.

2.5.19. When reassembling, check gaskets for integrity and groove seals for cleanliness.

2.5.20. Prior to reassembling separator #1 cap, check orifice for clog and orientation.

2.5.21. Reconnect the collector cup water lines with quick connect to original configuration before turning on the chiller/heater.

### 2.6. Closing Separation Vessels

2.6.1. The separators are closed with sanitary clamps.

2.6.2. Clamps are considered tight when both nuts are torqued to 20 ft-lbs. Uses the supplied torque wrench to accomplish this tightness.

2.6.3. A final visual check before starting the system is good practice, gaps between clamps should be around a 1/16-In to 1/8-In between opposing sides of the clamp as seen in the figure below).
2.7. Maintenance After Every Run

2.7.1. Includes harvesting oil and cleaning separator #1 as described above in Section 2.5.

2.7.2. Separator #2
   2.7.2.1. Remove Separator #2 inlet and outlets line from separator cap.
   2.7.2.2. Remove the top sanitary clamps and inspect Separator #2 for oil carryover.
   2.7.2.3. Clean Separator #2 if any oil is present.
      2.7.2.3.1. Remove bottom sanitary clamp.
      2.7.2.3.2. Use the 3” squeegee and cleaning agent to thoroughly clean the inside of the separator
      2.7.2.3.3. Clean bottom cap and check gasket for integrity and groove cleanliness prior to reassembly.
   2.7.2.4. If there is no oil carryover than check top cap gasket for integrity and groove for cleanliness prior to reassembling clamps.
   2.7.2.5. Clean connection piping between Separator #1 and #2 and reassemble.
   2.7.2.6. Ensure separator caps are secured on top and bottom of separators, and all flexible metal hoses are connected with the exception of the Separator #2 outlet line.

2.7.3. Separator #2 Outlet to Pump Inlet
   2.7.3.1. Ensure Valve 11 is open
      2.7.3.1.1. If Valve 11 isn’t open, then go to the manual screen and hit “Evacuate”. This will open up Valve 11.
2.7.3.1.2. If the evacuation button is not present this means there is entrained pressure somewhere in the system still and you may need to reassemble the vessels and finish the recovery. Check for pressure on the I/O Screen

2.7.3.2. Disconnect the separator outlet line, if not already disconnected, from the cap of Separator #2 as shown below.

![Figure 9. Image of separator outlet line after being disconnected.](image)

2.7.3.3. Remove the filter housing and filter on the back of the system. Inspect filter and housing for oil. Clean housing and clean/replace filter as necessary.

![Figure 10. Filter Housing.](image)
2.7.3.4. Pour cleaning agent into the separator outlet line using the supplied squeeze bottle until the solvent is colorless coming out the end that was connected to the pump inlet. After no color appears in solvent, use compressed air to blow out the line to ensuring that NO residual alcohol remains in the line between the separator and the pump.

2.7.3.5. Reconnect the separator outlet lines and reassemble filter.

2.7.3.6. The separator outlet line must be cleaned after every extraction.

2.8. Opening Extraction Vessel

WARNING

DO NOT ATTEMPT TO OPEN A VESSEL UNDER PRESSURE!
Always make sure a vent path for the vessel is opened and the corresponding pressure gauge(s) reads zero prior to loosening the vessel closure bolts.

2.8.1. This operation cannot be performed during an extraction. The extraction must be stopped prior to opening the Extraction vessel.

2.8.2. Venting of the Extraction vessel happens automatically at the end of recovery.

2.8.3. If the system is stopped and still has pressure you can go the “Manual Screen”

2.8.3.1. You can choose to either hit “Recover CO₂”, which will recover the CO₂ back into the bottle.

2.8.3.2. Or “Open Extractor Vessel” button, which will vent all CO₂ present in the vessel out of Valve 4.

2.8.3.3. If the extractor is under pressure, the system will require the operator to acknowledge that they want to vent all the CO₂ in the extractor.

2.8.4. When the extractor vessel gauge on top of the vessel and on the home screen both read zero, it is safe to move to the next step.

2.8.5. Use the supplied rubber mallet to loosen the extractor hammer unions from the top or bottom flange.
2.8.5.1. **CAUTION:** Extractor flange can weigh up to 50lbs and care should be given to avoid damage and injury.

2.8.6. Pivot the top flange toward the back and let it rest on the integral hinge stops. The bottom hammer union may not have a hinge, and must be lowered gently to prevent injury or damage to the remote probe and/or hammer union.

2.8.6.1. Use caution not to scratch or otherwise damage the sealing surfaces on the flanges.

![Figure 12. Appearance of extractor vessel in open condition.](image)

2.9. **Removing Spent Material from Extraction Vessel**

2.9.1. Once the extraction vessel is open, the spent botanical material can be removed. It is recommended to remove all material from the top of the extractor using a large shop vac.

2.9.2. Alternatively, the bottom vessel closure can be opened using the same instructions provided above. With the bottom closure open the botanical will fall out of the vessel and can be collected in a bag or other collection device.

2.9.2.1. **WARNING:** you will have to remove the temperature probe before opening the bottom vessel closure. Failure to do so may result in bending and/or damaging the temperature probe.

2.9.2.2. **CAUTION:** removing material from the bottom can cause material to get into threads on the closure nut. Threads will need to be cleaned before reassembly.

2.9.2.3. **CAUTION:** Extractor flange can weigh up to 50lbs and care should be given to avoid damage and injury.

2.10. **Loading Botanical Material or Other Media**

2.10.1. Prior to loading material visually check temperature probe and filter at the bottom as best you can from the top of extractor vessel.

2.10.1.1. **CAUTION:** Extractor flange can weigh up to 50lbs and care should be given to avoid damage and injury.
2.10.2. Material to be extracted is loaded directly into the extraction vessel. A supplied funnel can be used to help minimize spillage.

2.10.2.1. Typically, botanicals perform best in CO2 extractions when ground to a particle size between 200 µm and roughly the consistency of coffee grounds.

2.10.2.2. Any amount of material can be loaded into the Extraction Vessel – the vessel does not have to be full in order to operate correctly.

2.10.3. Gentle compression or packing can be used to increase the amount of material loaded in the vessel, however heavy compaction should be avoided because it can cause channeling of CO2 during the extraction process.

2.11. Closing Extraction Vessel

2.11.1. Ensure all sealing surfaces are clean and free of debris.
2.11.2. Check the Cup seal or O-ring for any visible damage or defects. Replace if necessary.
2.11.3. Ensure the thread of the extractor are free of debris and greased with the supplied bottle of anti-seize as shown below.

![Figure 13. Supplied bottle of Anti-Seize and threads](image)

2.11.4. Thread on the hammer union. Use supplied rubber mallet to fully close vessel 3 to 5 hits past hand tight. The nut should close to approximately the same location each time. If it does not then there may be debris in the threads that needs cleaned out.

2.11.4.1. If threads need cleaning remove all anti-seize lubricant from threads on both the vessel and the nut.

2.11.4.2. Once all old material is removed reapply thin new layer.

2.12. Chiller Startup

2.12.1. Every 80 hours verify chiller coolant level in chiller reservoir. If necessary, top off appropriate mix of distilled water and propylene glycol. Glycol percentage can be determined using a refractometer with is available on the online store.

2.12.2. Every 40 hours clean air filter on front of chiller.
2.12.3. Verify chiller cooling lines are connected to the extraction system
2.12.4. Basic chiller commands

2.12.4.1. Turn on chiller: press the power button on the front of the chiller. If that does not work check to make sure the chiller is connected to power and the breaker on the back of the chiller is on.
2.12.4.2. Set the target pressure: from the main screen, when setpoint is highlighted press enter to take you to the current setpoint. To adjust setpoint press enter again till setpoint is flashing. Use arrows to turn the setpoint up or down and then save by pressing enter.

2.12.4.3. Other options: other options such as changing units and monitoring values are located under the menu section. Refer to chiller manual for more detail.

2.12.5. Check I/O Screen to verify there is water flow. If no water flow is detected check connections.

2.13. Evacuating System (Pulling Vacuum)

2.13.1. After loading material, and ensuring all vessels are closed and ready for normal operation, from the Home Screen (see Figure A1), click the Manual Screen Button.

2.13.2. From the Manual Screen (see Figure A2), click the Evacuate Button.

2.13.2.1. Evacuation button will not appear if there is any pressure in the system. Refer to the I/O Screen to find where there is pressure and relieve.

2.13.3. Verify that all the gauges on the system display zero pressure.

2.13.4. Verify that the supplied vacuum pump is filled with the appropriate oil.

2.13.4.1. Refer to the vacuum pump owner’s manual for more detailed information.

2.13.5. Connect the vacuum gauge, blue vacuum hose and vacuum pump to the Evacuation valve on the bottom of Separator #2.

2.13.6. Open the Evacuation Valve.

2.13.7. Turn on the vacuum pump.

2.13.8. Allow the pump to run for approximately 5-min or until the gauge is below 25 inHg (inches mercury).

2.13.8.1. If the vacuum gauge does not reach -20 inHg, there may be a leak in the system or a vessel not closed.


2.13.10. Turn off the vacuum pump.

2.13.11. Disconnect the pump assembly (vacuum gauge, blue vacuum hose and pump).

2.13.12. Press the message button acknowledging that the evacuation is complete.


2.13.14. CAUTION: Never depressurize separation vessels with the evacuation valve while vacuum pump or gauge is attached.

2.14. Conducting an Extraction

2.14.1. If the green start button is not present at the bottom of the home screen, then do one of two things:

2.14.1.1. Push the orange button on the bottom of the home screen that says maintenance is required, and this will then turn into a green start button.

2.14.1.2. Push the green button on the top right corner of the screen that says “Return to Auto Mode”, and then a green start button will appear on the bottom of the home screen.

2.14.2. Verify that a 50-lb, 75-lb or 100-lb cylinder of CO₂ with a sufficient amount of CO₂ is connected to the system. Refer to the Pre-Training Checklist for suggested bottle quantities. Any time the bottle has less than 400psi, the pressure is considered low.

2.14.3. Verify that material is loaded into extraction vessel and extraction vessel is properly closed.

2.14.3.1. The system can be run with no material in the extraction vessel. This can be used as a way to clean the stainless-steel tubing upstream of the separation vessel.

2.14.4. Verify that the Separator vessels are both closed and sanitary clamps are tight (torqued to 20 ft-lbs).

2.14.5. Press the Start button on the home screen.
2.14.6. After pressing start, the system will prompt the operator to follow the following steps.
   CAUTION: Failure to follow prompts could result in serious injury.
   2.14.6.1. Set Extractor Pressure (between 900-psi and 1900-psi)
   2.14.6.2. Set the System Run Time (between 1-hour and 48-hours)
      2.14.6.2.1. The recommended run time is dependent on the material being extracted and the
                     extraction parameters but is typically between 1.5 to 3 hours per pound. Refer to the
                     Recommended Parameters section
   2.14.6.3. Verify chiller is connected, turned on and set to the correct temperature.
   2.14.6.4. Verify the Extractor is properly closed.
   2.14.6.5. Verify the Separator is properly closed.
   2.14.6.6. Close Valve 10 and Evacuation Valve (if evacuation was not conducted these may be
               open, if it was then they should already be closed).
   2.14.6.7. Open the CO₂ Bottles.
   2.14.6.8. If you have a single extraction vessel the system will start filling the vessels with CO2 to
               the target extractor pressure.
      2.14.6.8.1. If you have two extraction vessels the screen will prompt you to choose which
                  extraction vessel you will be using, either “a” (Extractor A only), “b” (Extractor B only)
                  or “c” (both extractor A and B at the same time).
      2.14.6.8.2. After choosing which extraction vessel(s) you will be using, the screen will prompt
                  you to close and/or open valves 3A and 7A or 3B and 7B depending on which
                  extraction vessel(s) you chose to run.
      2.14.6.8.3. Then the system will start filling the vessels with CO2 to the target extractor(s)
                  pressure.
   2.14.6.9. During the filling stage the Home Screen will display a blue box labeled “Startup” to inform
               the operator of the systems current activities.
   2.14.7. Once the target extractor pressure is reached, the system information box will change from
           “Startup” to “Running”. An additional information box will appear indicating the direction of the
           flow, either “Forward Flow” or “Reverse Flow”.
      2.14.7.1. Forward flow refers to CO2 entering the top of the vessel and exiting the bottom. Reverse
                  flow enters the bottom and leave the top.
      2.14.7.2. The system switches the flow direction every run to flow clean CO2 through the filter
                  elements on the extraction vessel.
   2.14.8. The system will continue in run mode until it reaches the target run time, at which point it will
           begin recovering the CO₂ into the CO₂ cylinder. The information box will switch from
           “Running” to “Recovering”.
   2.14.9. At the end of recovery, the system will automatically vent the extraction vessel but the
           separation vessels will have approximately 100-psi in them. The system will provide message
           boxes to instruct the operator through the final shut down process. The prompts are:
   2.14.10. Once the operator acknowledges that the CO₂ cylinder are closed and Valve 10 is open, the
            system will open all valves, vent any trapped CO₂ and wait for the next command

2.15. Recommended Operating Parameters

2.15.1. Recommended default parameters are intended as a starting point and it is up to the operator
         to determine best results for their operation. Please note that ambient temperature effects
         parameters and the system will take an hour to equalize out.
2.15.2. Subcritical runs result in lighter color oils and less waxes while supercritical runs decrease
         time and can increase yield.

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2.15.3. **PDC 3 Diaphragm Compressor**

**Subcritical:**
- Target Pressure: 1,200 psi
- Chiller Setting: 70 - 75F
- Propylene Glycol Percentage: 10%
- Orifice Size: 22
- Resultant Separator Pressure: 350-400psi
- Resultant Separator Temperatures: +/- 5 degrees around 25F
- Extraction Time: 2-3 hours per pound

**Supercritical:**
- Target Pressure: 1,800 psi
- Chiller setting: 105 - 110F
- Propylene Glycol Percentage: 10%
- Orifice Size: 18
- Resultant Separator Pressure: 350-400psi
- Resultant Separator Temperatures: +/- 5 degrees around 35F
- Extraction Time: 1-2 hours per pound

2.15.4. **PDC 4 Diaphragm Compressor**

**Subcritical:**
- Target Pressure: 1,200 psi
- Chiller Setting: 70 - 75F
- Propylene Glycol Percentage: 10%
- Orifice Size: 37
- Resultant Separator Pressure: 350-400psi
- Resultant Separator Temperatures: +/- 5 degrees around 25F
- Extraction Time: 2-3 hours per pound

**Supercritical:**
- Target Pressure: 1,800 psi
- Chiller setting: 105 - 110F
- Propylene Glycol Percentage: 10%
- Orifice Size: 29
- Resultant Separator Pressure: 350-400psi
- Resultant Separator Temperatures: +/- 5 degrees around 35F
- Extraction Time: 1-2 hours per pound
3. Troubleshooting

3.1. Ice on Separator or Collection Cup

It is normal for the high pressure clamps and flexible metal lines on the top of the separator to form ice during operation. If ice is forming on the outside of the separator vessels this is an indication that there could be a flow restriction inside the separator cooling jacket. The system should be shut down by pressing the Recover CO\textsubscript{2} Button on the Manual screen. This will put the system into recovery mode so that the cooling system can be inspected.

Ensure that the chiller/heater is turned on. Ensure that all blue coolant lines are properly connected. Ensure that the collection cup coolant lines are properly connected to the first separator. Ensure that the correct size orifice is being used inside Separator 1. Normal operating pressures within the separators is between 320-400psi. If pressures are much lower than 250psi, then ice may start to form on the separators. Also ensure that the temperature of the surrounding environment is no colder than 60°F, it is possible for the chiller/heater to have difficulty maintaining system temperatures if the surrounding environment is to cold.

Do not attempt to work on the cooling system while the system is running.

3.2. Low Extractor Pressure

If the extractor pressure is unable to meet the target pressure, first verify that the CO\textsubscript{2} cylinder has sufficient CO\textsubscript{2} (bottle gauge above 400 psi). If the bottles have plenty of CO\textsubscript{2}, check to see if the orifice size is too large (if separator pressure stays above 400 psi this may be an indication). Finally, check to see if the pump outlet is hot (Caution: can be up to 160 F). If pump outlet is cool, the pump may have lost prime, follow priming instructions in Appendix.

3.3. Extractor Overpressure

The valveless expansion technology uses a small orifice to regulate pressure. This orifice can become plugged when foreign material is entered into the plumbing between the extraction vessel and separator vessel.

In the event that separator pressure decreases and/or extractor pressure increases causing an extractor high pressure fault, it is most likely a clogged orifice or your orifice you are using is too small. Follow the steps below to clear an orifice clog:

i. From the Home Screen, Press the Manual Screen Button.
ii. From the Manual Screen, Press the Service Separator Button.
iii. Wait for the system to provide a message popup indicating it is safe to Open Valve 10 and clean the orifice.
iv. Open Valve 10
v. Verify that both Separator vessel gauges read zero.
vi. Remove the CO\textsubscript{2} lines from the top of the separators. Use two wrenches to prevent from bending tubes or the NPT fittings from loosening in the separator cap.

vii. Remove the yellow wire connected to the Separator #1 thermocouple.

viii. Remove vent tube from relief valve.
ix. Use the 5/8-in ratchet wrench to remove the high pressure sanitary clamps from the top of Separator #1.

x. Remove the cap from the top of Separator #1.

xi. Ensure you are using the correct size orifice and inspect for clogs.
xii. Clean the orifice by soaking it in alcohol and blowing it out with compressed air. Verify the orifice is clear by looking through it.
xiii. An orifice cleaning tool is available on the online store for stubborn clogs.
xiv. Reassemble the orifice.
xv. Replace the separator cap and tighten the clamp bolts to 20 ft-lbs.
xvi. Reinstall the CO2 connections and the thermocouple wire.
xviii. Press the popup message button when orifice is reinstalled, the high pressure clamps are tight and the flexible hoses are reconnected.

3.4. Low Separator Pressure

Low Separator pressure is typically caused by one of two things (an orifice clog or the wrong size orifice installed). If the system has been operating has lower than normal separator pressure or does not seem to equalize this may be an indication of a clogged or partially clogged orifice. To correct an orifice clog refer to the instructions in the section above (Extractor Overpressure).

3.5. Wrong Orifice Size

Orifice size dictates the relationship between the separator and extractor. The main goal is to maintain the separator pressure around 320-400 psi. While the system may run at higher or lower pressure just fine, CO2 flow may not be optimal with lower pressures or you may be at risk for more carryover with higher pressures. The smaller the orifice size the lower the separator and vise versa. Several orifice sizes are shipped with each machine that will run any parameter on the machine but additional sizes for any specific optimization are available on the online store. Follow service separator instructions to change orifices.

3.6. Differing Separator Pressures

Differing Separator Pressures means there is a clog in the tubing between the two separators as they should be around the same pressure (+/- 10 psi). To check for obstructions, follow the service separator instructions in Section 3.3 and check tubing.

3.7. Oil Carryover to Separator #2 or Filter Housing

Oil carryover can be detected during every run maintenance when cleaning the Separator #2 outlet to pump inlet and when spot checking Separator #2. Light carryover can/will occur. The presence and severity of oil is an indication of carryover to the pump. While slight oil can be tolerated, the pump was not designed to have oil circulating through it. Oil carryover will reduce the life of the pump and can damage the pump if severe. If a large amount of carryover is detected (more than a couple grams) check the following items during the next run:

i. Separator temperatures are above 40F after system is equalized, usually after 1 hour after initialing. The temperature set point on the chiller has a direct relationship with separator temperature. Turn the set point on the chiller down until separator temperature is below 40F.

ii. Extreme cold temperatures in separators cause oil carryover as well. If the separator is encased in a block of ice the temperature is more than likely a tad too cold. Ensure that the chiller is on and correctly functioning before beginning a run, water lines are correctly assembled between the collector cup and the separator, and the water line quick connects have disengaged the check valves.

iii. For both case check water line connections, chiller settings and water to propylene glycol percentages.
4. System Maintenance

This maintenance schedule is based on the maintenance timer on the Maintenance Screen (see Appendix A).

4.1. Extraction System Maintenance

Included with each system is a small squeeze bottle to help with proper maintenance and cleaning of your systems CO₂ lines. Alcohol (200 proof) is a typical and acceptable cleaning agent. Please label the bottle accordingly.

![Image of chemical squeeze bottle]

Figure 14. Front and back of chemical squeeze bottle

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Maintenance Item</th>
</tr>
</thead>
<tbody>
<tr>
<td>After Each Extraction</td>
<td></td>
</tr>
<tr>
<td>• Remove extracted oil from collector cup and separator walls, clean walls and cup with alcohol.</td>
<td></td>
</tr>
<tr>
<td>• Check separator 2 for oil carryover and clean if necessary.</td>
<td></td>
</tr>
<tr>
<td>• Inspect separator gaskets and grooves prior to reassembly.</td>
<td></td>
</tr>
<tr>
<td>• Clean piping between separator 1 and 2 with alcohol.</td>
<td></td>
</tr>
<tr>
<td>• Clean Separator 2 CO₂ outlet to pump inlet, ensure valve 11 is open.</td>
<td></td>
</tr>
<tr>
<td>• Remove spent material from the extraction vessel by vacuuming it out through the top flange.</td>
<td></td>
</tr>
<tr>
<td>• Verify the extractor filters are clear and free of debris</td>
<td></td>
</tr>
<tr>
<td>• Check extraction vessel O-rings and O-rings groove sealing surfaces for damage – replace if necessary</td>
<td></td>
</tr>
<tr>
<td>• Inspect the surfaces on Extraction vessel to make sure they are free from dust and debris. Failure to clean surfaces properly can cause vessel not to seal properly or damage to the cup seal.</td>
<td></td>
</tr>
<tr>
<td>Every 80 Hours</td>
<td></td>
</tr>
<tr>
<td>• Run the system “empty of plant material” for 1 hour to clean the high pressure side of the system and extraction vessel(s)</td>
<td></td>
</tr>
<tr>
<td>Yearly</td>
<td></td>
</tr>
<tr>
<td>• Check torque on all screws in electrical panels (see Appendix D)</td>
<td></td>
</tr>
<tr>
<td>Resource</td>
<td></td>
</tr>
<tr>
<td>Apeks online store</td>
<td><a href="http://www.apekssupercritical.com/online-store/">http://www.apekssupercritical.com/online-store/</a></td>
</tr>
</tbody>
</table>
### 4.2. Diaphragm Compressor Maintenance

See Diaphragm Compressor Manual for specific instructions on maintenance items. Below is general system information.

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Maintenance Item</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily</td>
<td>• Check oil level&lt;br&gt;• Check oil pressure&lt;br&gt;• Listen for abnormal noise or vibration&lt;br&gt;• Check Leak Detection System status</td>
</tr>
<tr>
<td>Every 500 Hours</td>
<td>• Change Diaphragm Compressor Filter located on suction side tubing.&lt;br&gt;• Check belt tension (See Appendix B)&lt;br&gt;• Clean process check valves</td>
</tr>
<tr>
<td>Every 1500 Hours</td>
<td>• Preform regular oil change&lt;br&gt;• Check torque on all screws in electrical panels (see Appendix D)</td>
</tr>
<tr>
<td>Every 4000 Hours</td>
<td>• Replace diaphragms and o-rings in process head&lt;br&gt;• Clean and inspect oil inlet check valve&lt;br&gt;• Clean and inspect oil relief valve&lt;br&gt;• Inspect crankcase assembly&lt;br&gt;• Inspect compressor lower head&lt;br&gt;• Clean and inspect injection pump assembly</td>
</tr>
</tbody>
</table>

### 4.3. Chiller Maintenance

See Chiller Manual for specific instructions on maintenance items. Below is general system information.

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Maintenance Item</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weekly</td>
<td>• Check fluid level&lt;br&gt;• Check fluid filter bag and clean/replace as necessary&lt;br&gt;• Listen for abnormal noise or vibration&lt;br&gt;• Check for any leaks&lt;br&gt;• Clean condenser filter (air filter) on front bottom of chiller</td>
</tr>
<tr>
<td>Every Month</td>
<td>• Check/Clean fluid diffuser</td>
</tr>
<tr>
<td>Every 6 months</td>
<td>• Replace cooling fluid</td>
</tr>
</tbody>
</table>
5. References

YouTube Instructional Videos
https://www.youtube.com/user/ApeksSupercritical

Apeks online store (740)-809-1166 ext. 4
http://www.apekssupercritical.com/online-store/

Software Updates and E-mail Alerts (740)-809-1166 ext. 1 or ext. 5
http://www.apekssupercritical.com/service/
Appendix A.
2000psi System Screen Shots and Descriptions
A. Screen Shots

a. Home Screen

The home screen is where all pressures, temperatures, run times, and access to other screens are located. This is where you will enter your parameters and start your extractions.

Figure A1. Home Screen single system.

b. Manual Screen

The manual screen is used quite often, and is where to go to perform any operations other than normal operation such as clearing a clogged orifice, recovering CO$_2$ before the entered run time is complete, opening the extractor vessel, or changing a CO$_2$ bottle.

Figure A2. Manual Screen
On the manual screen, there’s a button to switch between automatic flow reversal and manual flow reversal. When in manual flow reversal mode, the operator can press a button to switch the flow direction at any time during the run.

When in automatic flow reversal, the machine will only change flow direction when a new extraction is started, meaning that forward flow at the beginning will remain forward flow until the next run. The next run will be reverse flow and will remain reverse flow for the entire run.

c. Maintenance Screen

The Maintenance screen is where you will go to monitor run times on your system and pump for scheduling and maintenance.

![Maintenance Screen](image_url)

Figure A3. Maintenance Screen
d. Logo Screen

The Logo Screen shows the system software revision number is located in the bottom left of this screen. The reason for the logo screen is to hide any potentially secret parameters on the home screen.

![Logo Screen](image)

Figure A4. Logo Screen

e. I/O Status Screen

The I/O screen is used for troubleshooting. On this screen, you can monitor which valves are supposed to be open and closed, if the pump is on or off, and if the light on top of the machine is green or red. There are also indicators showing thermocouple raw input data as well as air and CO$_2$ pressures in PSI.

![I/O Status Screen](image)

Figure 1. I/O Status Screen
f. Alarm Screen

The Alarm screen is used for troubleshooting, and where navigation to text messaging screen is located. When the system faults for any reason, it is recorded on the alarm screen. A lot of times the fault you see on the home screen may have been caused be a series of faults. By looking at the alarm screen you can see all the previous faults in the order that they occurred.

![Alarm Screen Diagram]

Figure 2. Alarm Screen
Appendix B.
Belt Tension Testing/Adjustment
B. Belt Tension Testing and Adjustment

a. Remove belt guard

![Figure B1.](image1)

b. Check belt(s) tension with belt tension tester. PDC-4 belts should be tensioned to 10lbs and PDC-3 belts should be tensioned to 6-7lbs.
   i. If you need help using your tension tester tool please view the following video
   ii. [https://www.youtube.com/watch?v=bYEHvfo8t6A](https://www.youtube.com/watch?v=bYEHvfo8t6A)

![Figure B2.](image2)
c. If the belt needs adjusted loosen the 4 bolts holding the motor to the base

Figure B3.

d. Before moving the motor retighten the bolts to finger tight (this keeps the motor from lifting up on one side during adjusting due to the belt tension).

e. Adjust the set screws on the motor base in or out to tighten or loosen the bolt as necessary.

Figure B4.

f. Be sure to check motor shaft alignment (note: can be up to 1/8” difference from side to side).
g. Retighten motor bolts.

h. Rotate the belt by hand around one turn (failure to do so could result in an incorrect reading).

i. Check belt tension again and repeat as necessary
Appendix C.
Diaphragm Pump Priming Instructions
C. Diaphragm Pump Priming

a. Open the over pump bypass valve, see figure below, by turning counterclockwise until it stops.

b. Go to the “Manual Screen” on the HMI and hit the “Start Prime Compressor” button.

c. When pump is priming verify there is oil pressure on the pump gauges, if no pressure appears check oil level and pump motor rotation.

d. Continue to let the pump run 3 to 4 min to remove any entrained air in compression head.

e. Begin to close over pump bypass valve slowly, 1 full turn every 5 to 10 seconds, until fully closed.

f. From the “Manual Screen” hit the “Stop Prime Compressor” button.

g. Start the system to see if pump is pumping properly.
Appendix D.
Electrical Screw Torque Requirements
D. Electrical Screw Torque Requirements

a. Fuse Holders (1492-H6) = 7.1 lb-in
b. Power Supply (1606-XLE120E) = 7 lb-in
c. Terminal Blocks (1492-J4) = 9 lb-in
d. Ground Blocks (1492-JG4) = 9 lb-in
e. Ground Block Middle Screw (1492-JG4) = 7.1 lb-in
f. JG10 Large Ground Blocks (1492-JG10) = 20.4 lb-in
g. JG10 Large Ground Block Middle Screw (1492-JG10) = 8.9 lb-in
h. Small Motor Contactor Phillip Screws (100-C55D10) = 31 lb-in
i. Small Motor Contactor (43-44) Phillip Screws = 13 lb-in
j. Overload Relay (T1/T2/T3) Phillip Screws = 22 lb-in
k. Overload Relay (95-98) Phillip Screws = 5 lb-in
l. Large Motor Contactor Allen Screws (100-C72D10) = 53 lb-in
m. Large Motor Contactor Phillips Screws (100-C72D10) = 13 lb-in
n. Overload Relay Allen Screws (193-EEGE) = 40 lb-in
o. Overload Relay Phillips Screws (192-EEGE) = 5 lb-in
p. Micro 850 Power Supply = 4.4 lb-in
q. Micro 850 Terminal Strip = 4.4 lb-in
r. 2080 TC2 = 2.21 lb-in
s. 2080 IF4 = 2.21 lb-in
t. 2080 IF2 = 2.21 lb-in
u. HMI = 5 lb-in
v. Yellow Terminal Jumpers = 7.1 lb-in
w. Estop Contact (800F-X01) = 8 lb-in
x. Relay Base Screws (700-HN153) = 7 lb-in
y. IF8 = 5.3 lb-in
z. Relay Output Module = 5.3 lb-in
aa. 10A Circuit Breaker (18 AWG) = 13.3 lb-in
bb. 10A Circuit Breaker (14 AWG) = 17.7 lb-in
cc. 10A Circuit Breaker (8 AWG) = 39.9 lb-in
dd. Ewon Flexy Power Connector = 7 lb-in
e. Ewon Cosy Power Connector = 7 lb-in
ff. 125V Plug = 12 lb-in
Appendix E.
Piping and Instrumentation Diagram
E. Piping and Instrumentation Diagram
Appendix F.
CO₂ Phase Diagram
F. CO$_2$ Phase Diagram
Appendix G.
Pre-Training Checklist
G. Pre-Training Checklist

In preparation of training,

Please refer to the manual above for unpacking and setup instructions. Below is a check list of what needs to be purchased or completed BEFORE scheduling your onsite training. Onsite training is a four-hour block of instruction that is NOT designed to include unpacking and setup. Incomplete items at the time of onsite training will result in incomplete training or additional charges for rescheduling.

Our training process is as follows:

1. Customers to reference Apeks manual for instructions on un-crating and system setup
2. Customer to complete entire Pre-Training Checklist
3. A Face Time or Skype session is required (when available) to ensure Checklist is complete, setup is correct and the session is to cover basic operation and cleaning of the system
4. After 1 through 3 are complete, scheduling of onsite training can occur and it will be a 1-3 week lead time.

Pre-Training Checklist:

Below is a check list of what needs to be purchased or completed BEFORE scheduling your onsite training.

- **Must be complete before scheduling training:** Print off complete Apeks manual and have on site the day of training, along with the manual to the chiller. Use this link to download the manual if needed,

- **Must be complete before scheduling Training:** Apeks system and diaphragm compressor are unpacked and setup in its location of operation. Refer to unpacking instructions in the manual.

- **Must be complete before scheduling training:** See manual for electrical requirements of your system. All electrical connections are to be completed before onsite training is scheduled.

- **Must be complete before scheduling training:** Purchase and have on site for training:
  - Bottles of CO2, gas feed, check valve free, food grade or better. Minimum requirements are:
    - (3) 50 lb. bottles for 5LD and 5Lx5LD, (4) 50 lb. bottles for 20LD, (4) 75 lb. bottles for 20Lx20LD
  - Distilled water and Propylene glycol 90/10 mix; [Propylene Glycol - 1 Gallon](#)
  - Total Gallons of mixture needed for system:
    - 5LD – 5 gal, 5Lx5LD – 6 gal, 20LD – 7 gal, 20Lx20LD – 9 gal
  - 190 or higher proof ethanol
Future maintenance will require:
  - Shop Vacuum with a long, slim nozzle for removing material from extractor.
  - Pencil Type Belt Tension Tester; [http://apeksonlinestore.com/product/tension-tester/](http://apeksonlinestore.com/product/tension-tester/)
  - CO2 Monitor; [Amprobe CO2 100](http://www.amprobe.com/products/co2-monitor-co2-100)

Material to be extracted must be very dry and grinded (blender) to the consistence of coffee grounds. Have ready the day of training as a courtesy to your trainer.

After completing the pre-training checklist, request scheduling of onsite training via the link, [http://www.apekssupercritical.com/training/](http://www.apekssupercritical.com/training/)

Onsite training is generally a 4-hour block of instruction that will go into detail the fundamentals of operation and maintenance of each component of the system.