WARNING

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

Apeks LLC
150 Commerce Blvd.
Johnstown OH 43031
740-809-1160
www.apekssupercritical.com

Scan this QR code to get the most recent version of this manual!
1. System Operation
The following operating instructions are for the 5000-5Lx5L DP, 20Lx20L DP and 40Lx40L DP, CO$_2$-based Botanical Oil Extraction systems. Instructions assume that chiller and CO$_2$ Booster Pump are OEM (Original Equipment Manufacturer) supplied. Failure to follow the instructions provided below may void the warranty of the 5000-5Lx5L, 20Lx20L, and 40Lx40L systems.

1.1. 5000-psi System Overview

1.2. Automation Systems Overview
1.2.1. 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, with the exception of the Air Compressor and Chiller, which operate independently.
1.2.2. The HMI has two functions; 1) to provide information and 2) to accept inputs from the operator. Descriptions of some of the interactions:
   1.2.2.1. If a display value or message is colored orange, an operator must take action before progressing forward.
1.2.2.1. Orange indicates that operator activity is required before the Start button can be depressed. Messages highlighted orange are indicative of a scheduled maintenance interval being reached.

1.2.2. Red messages indicate that a component of the system has either failed to reach the minimum operating pressures or temperatures, or that a component of the system 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.

1.2.2.1. 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.

1.2.2.3. 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.

1.2.3. Any variable or message that needs to be (or can be) controlled by the operator is 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)

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

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

1.2.6. The primary operating valves on the system are air-actuated valves controlled by the system's controller. In the event of an Air Compressor failure or a power failure, all air-actuated valves will return to their normally closed resting state. Valve 0, 17, 30A and 30B will be open and all others will be closed.

1.2.7. Each air-actuated valve has an indicator on the top to inform the operator which valves are open and which valves are closed. The indicator lines correspond with the flow direction. The following figure illustrates both an 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.
1.3. Pre-Cleaning

1.3.1. The 5000-psi systems are 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. Simple Green cleaner, ethanol/alcohol work well for most applications.

1.3.2. The 5000-psi system should be cleaned to the appropriate level (determined by your application and corresponding regulations) prior to processing each batch of botanical material.

1.3.2.1. Apeks takes great care to clean all systems prior to shipping. However, it is the user’s responsibility to ensure that the system meets the required level of cleanliness.

1.4. 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 trying to open vessel

1.4.1. An Extractor Vessel can only be opened if it is not selected for use and the pressure has been released. Otherwise, the extraction must be stopped prior to opening the Extractor Vessel.

1.4.2. To open vessel, verify there is no pressure in the Extraction Vessel. If a small amount of pressure is present, locate the hose on top of the vessel and loosen hose fitting 90 degrees to allow CO$_2$ to escape. Wait for pressure to subside. Never loosen the hose any more than 90 degrees because the hose could disconnect and cause damage or injury. If pressure is higher than 50-psi and the system is not running, from the Home Screen (see Appendix A, page 23), press “Go To Manual Screen” button.

1.4.2.1. From the Manual Screen (see Appendix A, page 23), press the “Open Extractor Vessel” button. Note: This will vent both Extractors.

1.4.2.2. If the Extractor is under pressure, the system will require the operator to acknowledge that he or she wants to vent all the CO$_2$ in the Extractor.

1.4.3. 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.

1.4.4. Remove Flexible Hose from the top of the Extractor, as shown below in Figure 4A.
1.4.5. Remove safety pin, as shown below in Figure 4B.

1.4.6. Rotate the plug inside the closure until the ears on the plug match up to the holes on the nut, as shown below in Figure 4C.
1.4.7. Attach chain hoist to eyebolt and carefully raise plug out of the nut, as shown below in Figure 5. Caution: Only use hoist to lift the plug, not the entire vessel.

1.4.7.1. Use caution when raising or lowering plug as to not damage cup seal. Note: Keep the plug horizontal, move it slowly, and do not force it to seal.
1.5. Loading Botanical or Other Media

1.5.1. Material to be extracted is loaded directly into the extraction vessel. The supplied funnel can be used to help minimize spillage.

1.5.1.1. Typically, botanicals perform best in CO$_2$ extractions when ground to a particle size of about 200 µm, roughly the consistency of coffee grounds.

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

1.5.1.3. Use caution not to overfill the vessel. The vessel plug sits down inside the tube and seals on the inner surface. Overloading can cause vessel not to seal or damage the cup seal.

1.5.2. Gentle compression or packing can be used to increase the amount of material loaded into the vessel. However, heavy compaction should be avoided because it may cause clogging during the extraction process.

1.6. Closing Extraction Vessel

1.6.1. Ensure all surfaces are clean and free of debris.

1.6.2. Check the cup seal on the plug for any visible damage or defects. Replace as necessary.

1.6.2.1. The cup seal does not require any lubrication.

1.6.3. Close the vessel by placing the plug back into the nut and rotating until the safety closure pinhole is in the correct location.

1.6.1. Insert safety closure pin and reattach flexible CO$_2$ hose, as shown below in Figure 6B.

![Figure 6A. Closing Vessel](image)
1.7. Chiller Start Up
   1.7.1. Verify that both chillers’ cooling lines are connected to the extraction system.
   1.7.2. Turn chiller on.
      1.7.2.1. The main power switch is located on the back of the chiller.
      1.7.2.2. The operation power button is located to the left of the display on the front.
   1.7.3. Set the target temperature that corresponds with each coolant loop in the system.
      Target temperatures can be found in recommended operating parameters section.
   1.7.4. Verify coolant flow for both storage and water extractor loops on “I/O Screen.”

1.8. Evacuating the System (Removing moisture and checking for leaks prior to extraction)
   1.8.1. Three separate types of evacuation can be performed:
      1.8.1.1. Evacuation of system with Separator 1.
      1.8.1.2. Evacuation of system with Separator 2.
         1.8.1.2.1. Evacuation of both Separator 1 and 2 can be done by switching between
                     the vessels after one is fully evacuated.
      1.8.1.3. The third type of evacuation is a storage evacuation. It’s an entirely
                     separate button that is only visible when storage tank is empty. It opens a path
                     to storage tanks in addition to the rest of the system. This should be done after
                     a storage tank cleaning and before initial fill.
   1.8.2. After loading material and ensuring that all vessels are closed and ready for normal
         operation, from the Home Screen (see Appendix A, page 23), press the Manual Screen
         button.
   1.8.3. From the Manual Screen (see Appendix A, page 23), choose which Evacuate Button is
         necessary (Evacuate button will not appear if over 30-psi is present in the system).
   1.8.4. Verify that all the gauges on the system display zero pressure.
   1.8.5. Verify that the supplied vacuum pump is filled with the appropriate oil.
      1.8.5.1. Refer to the vacuum pump owner’s manual for more detailed information.
   1.8.6. Connect the vacuum gauge, blue vacuum hose and vacuum pump to the Evacuation
         Valve on the bottom of Separator #3, as shown below in Figure 7.
1.8.7. Open Evacuation Valve.
1.8.8. Turn on the vacuum pump.
1.8.9. Allow the pump to run until the gauge reaches -25 to -30 mmHg for 3 or 4 minutes. If pump cannot achieve this, then there is most likely a leak in the system or a vessel is not closed. Check all connections that have been opened since the last run before proceeding.
1.8.11. Turn off the vacuum pump.
1.8.12. Disconnect the vacuum gauge, blue vacuum hose and pump.
1.8.13. Press the message button, acknowledging that the evacuation is complete.

1.9. Conducting an Extraction
1.9.1. If the green start button is not present at the bottom of the Home Screen, then do one of two things:
   1.9.1.1. After performing the required maintenance cycle (weekly or monthly), push the orange button on the bottom of the Home Screen that says maintenance is required. This will disappear to reveal the green start button.
   1.9.1.2. Push the green button on the top right corner of the screen that says, “Return to Auto Mode.” A green start button will appear on the bottom of the Home Screen.
1.9.2. Verify the chillers are on and target temperature is set to desired temperature (refer to manufacturer’s recommended operating parameters).
1.9.3. Verify that a 50-lb, 75-lb or 100-lb cylinder of CO$_2$ with a sufficient amount of CO$_2$ is connected to the system. Pressures under 400-psi will not fill system properly.
1.9.4. Verify that material is loaded into Extraction Vessel and Extraction Vessel is properly closed.
   1.9.4.1. The system can be run with no material in the Extraction Vessel. This procedure is called a dry run and can be used as a way to clean the high-pressure side of the system.
1.9.5. Verify that the Separator Vessels are both closed and sanitary clamps are tight (clamps are considered tight when they are torqued to 20-ft lbs. with a torque wrench, which may leave a 1/16-in to 1/8-in gap between opposing clamps).

![Figure 8. Appearance of tight sanitary clamp](image)

1.9.6. Press the Start button on the Home Screen, see Appendix A on page 23.

1.9.7. After pressing Start, the system will prompt the operator to:

1.9.7.1. Set the Phase 1 Extractor Target Pressure (between 900-psi and 4800-psi). This is the pressure that the system will try to achieve while flowing through the Separator chosen to be online during Phase 1.

1.9.7.2. Set the Phase 2 Extractor Target Pressure (between 900-psi and 4800-psi). This is the pressure that the system will try to achieve while flowing through the other Separator not chosen in Phase 1.

1.9.7.3. Set the System Run-Time (both Phase 1 and 2 time, full hours between 1-hour and 48-hours).

1.9.7.4. Set the Phase 1 Run-Time (hours and minutes, must be less than or equal to full run time).

1.9.7.5. Select which Extractor to run, a = Extractor A only, b = Extractor B only, c = Both. Lower case letters must be used to select Extractor (This Extractor will run for the entire time, Phase 1 and 2 only refer to Separators).

1.9.7.6. After Extractor is selected, system will prompt you to close or open manual Valves 3A, 3B, 7A and 7B based on selection.

1.9.7.7. Verify both chiller and chiller/heater are on. Verify flow on I/O Screen, if necessary.

1.9.7.8. Verify Separators are properly closed.

1.9.7.9. Verify Extractors are properly closed.

1.9.7.10. Close Valve 10A, 10B. Evacuation Valve and Separator Line Cleanout Valve and verify Valve T1 and Valve T2 are open.

1.9.7.11. Open CO₂ Bottle.

1.9.7.12. Enter orifice size to be used in Phase 1.

1.9.7.13. Select Separator to be used in Phase 1.

1.9.7.14. The system will then start filling the vessels with CO₂ to the Extractor target pressure.

1.9.8. During the filling stage, the "Home Screen" will display a blue box labeled “Filling” to inform the operator of the system’s current activities.
1.9.9. Once the target Extractor pressure is reached, the system information box will change from “Filling” to “Running.” An additional information box will appear indicating the direction of the flow, either “Forward Flow” or “Reverse Flow.”

1.9.9.1. The system switches the flow direction every other run-to-run clean CO\textsubscript{2} through the porous metal filters. See section 1.10 for more information.

1.9.10. The system will continue in Phase 1 until it reaches the target run-time for Phase 1, at which point it will pump down the selected Separator to 100-psi and switch over to the Separator being used for Phase 2.

1.9.11. Before the system begins Phase 2 a pressure test must be passed for the Separator coming online. A small amount of pressure is added to the Separator and then closed off to verify the Separator is ready to hold pressure before fully pressurizing. If the pressure test is passed, the system will continue as normal. If not, the system will go into service Separator mode until the user fixes the leak and verifies the Separator is ready.

1.9.12. At the end of the full run-time, the system will automatically begin recovering the CO\textsubscript{2} into the storage tanks. The information box will switch from “Running” to “Recovering CO\textsubscript{2}” and the system will display that “Recovery has begun.”

1.9.13. At the end of recovery, the system will have approximately 100-psi in all the vessels. The system will provide message boxes to instruct the operator through the final shut down process. The prompts are:

1.9.13.1. Close the CO\textsubscript{2} cylinder.
1.9.13.2. Open Valve 10A and Valve 10B.

1.9.14. Once the operator acknowledges that the CO\textsubscript{2} cylinder is closed and Valve 10A and Valve 10B are open, the system will open all Valves except 22, 23, 17, 30A, and 30B, vent any trapped CO\textsubscript{2} and wait for the next command.

1.10. Automatic or Manual Flow Reversal

1.10.1. From the Manual Screen, the user can choose automatic or manual flow reversal.

1.10.1.1. This function (when in automatic) changes the direction of flow in the Extractor Vessels every other run from top to bottom, to bottom to top in order to flow clean CO\textsubscript{2} through the metal filters located on the Extractor plugs.

1.10.1.2. Manual flow reversal allows the user to switch flow direction at their choosing during a run. Note: Switching flow too often can cause diminished yields.

1.11. Changing Bottles

1.11.1. From the Manual Screen, select “Change Bottle.”

1.11.1.1. The system will prompt the user to close all bottle Valves and change the bottle. Note: User will have to release pressure in hoses by cracking the fitting at the bottle and allowing pressure to bleed off.

1.11.1.2. The system will keep all Valves going to the bottles closed during this time until user acknowledges that bottles are reconnected and opened.

1.11.2. Bottle pressures less than 400-psi will not allow proper addition of CO\textsubscript{2} to the system.

1.12. Removing Spent Material from Extraction Vessel (These steps are only necessary during cycle)

1.12.1. If cycle is complete and pressure is zero and system is not running, proceed to step 1.12.4.
1.12.2. From the Home Screen (see Appendix A, page 23), press the “Manual Screen” button.

1.12.3. From the Manual Screen (see Appendix A, page 23), press the “Open Extractor Vessel” button.

1.12.3.1. If the Extractor is under pressure, the system will require the operator to acknowledge that he or she wants to vent all the CO\textsubscript{2} in the Extractor.

1.12.4. When the Extractor Vessel gauge on top of the vessel and on the Home Screen both read zero, it is safe to open the Extraction Vessel(s).

1.12.5. 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.

1.13. Removing Oil from Collection Cup (End of Run)

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.

1.13.1. Verify that all Separator Vessel gauges and the Separator pressure on the Home Screen read zero and that Valve 10A and Valve B are open, as shown in Figure 9 below.

WARNING
OPERATOR NEEDS TO VERIFY THAT THERE IS NO PRESSURE IN THE LINES BETWEEN THE EXTRACTORS AND SEPARATORS BEFORE REMOVING THE HOSES. The operator can check the pressure on the gauge immediately under the left side of the Main Control Enclosure (MCE)
1.13.2. Remove all flexible lines from the top of the Separators, as shown below in Figure 10. Use two wrenches to remove hoses, as shown below in Figure 10 to prevent tubes from twisting.

1.13.3. Remove the yellow wire connected to the Separator #1 and 2 thermocouples.
1.13.4. Use the 5/8-in ratchet wrench to remove the high-pressure sanitary clamps from the top of both Separator Vessels.
1.13.5. Remove the caps from the top of all Separator Vessels.
1.13.6. Collect any available oil from the separator caps.
1.13.7. Use alcohol to clean the caps and orifice tube.
   1.13.7.1. Separator caps must be cleaned every run.
1.13.8. Use the supplied round squeegee to push any residual oil from the sides of the
   Separators down to the bottom of the Separators.
1.13.9. Use the 5/8-in ratchet wrench to remove the high-pressure sanitary clamps from the
   bottom of the Separator Vessels.
1.13.10. Turn off the chiller/heater.
1.13.11. Disconnect the two blue water line quick connects on the back of the collection cup.
1.13.12. Remove the collection cup from Separator #1 and Separator #2 and the bottom cap
   from Separator #3.
1.13.13. Collect the oil from inside the collection cup.
   1.13.13.1. Note: There is typically residual dry ice in the collection cup mixed in with
   the oil. The dry ice will sublime without any additional heat. It is
   sometimes more efficient to remove the dry ice/oil mixture and place it in
   a collection device (like a Pyrex dish).
1.13.14. Use the round squeegee and alcohol to thoroughly clean the inside of the Separators
   and collection cup.
1.13.15. Both Separators and the collection cup must be cleaned after each extraction.
1.13.16. Reassemble all Separators by reversing the steps above. The exception here is the
   sanitary clamps. The nuts on the sanitary clamps need to be inspected for thread
   wear or damage. The nuts on the sanitary clamps need to be replaced if they are
   worn or damaged and the nuts need to be put back on with a torque wrench at 20 lb.
   ft. Refer to Figure 8.
1.13.17. Reconnect the water lines before turning on the chiller/heater.

1.14. Removing Oil from Collection Cup (During Run)

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.

1.14.1. With the three-Separator arrangement, collection and servicing can be done on a
Separator during an extraction cycle. This can be accomplished at the end of Phase
1 or any time by manually switching between Separators on the “Manual Screen.”
1.14.2. Be sure to follow the instructions below as they are different from removing oil after a
run.
1.14.3. Verify that Separator Vessel gauge and the Separator pressure on the Home Screen
read zero and that Valve 10A or Valve 10B are open, depending on which Separator
is being cleaned (A for Separator #1 and B for Separator #2).

WARNING
OPERATOR NEEDS TO VERIFY THAT THERE IS NO PRESSURE IN THE LINES BETWEEN THE
EXTRACTORS AND SEPARATORS BEFORE REMOVING THE HOSES. The operator can check
the pressure on the gauge immediately under the left side of the Main Control Enclosure (MCE)
1.14.4. Fully remove all flexible lines from the top of the Separator, as shown below in Figure 11.

FIGURE 11. Appearance of separator with hoses removed before servicing during a run

**WARNING**

Failure to remove hose completely could cause damage or injury if system loses power or air pressure.

1.14.5. Use two wrenches to remove hoses, as shown above in Figure 10, to prevent tubes from twisting.
1.14.6. Remove the yellow wire connected to the Separator cap.
1.14.7. Use the 5/8-in ratchet wrench to remove the high-pressure sanitary clamps from the top of the Separator Vessel.
1.14.8. Remove the cap from the top of the Separator Vessel.
1.14.10. Use alcohol to clean the caps and orifice tube.
1.14.11. Use the supplied round squeegee to push any residual oil from the sides of the Separators down to the bottom of the Separators.
1.14.12. Use the 5/8-in ratchet wrench to remove the high-pressure sanitary clamps from the bottom of the Separator Vessels.
1.14.13. Bypass the water lines on the collection cup by disconnecting the quick connects on the collection cup and reconnecting them at the bottom of the Separator. Failure to reconnect the water lines within 30 seconds will cause the system to shut down.
1.14.15. Collect the oil from inside the collection cup.
   1.14.15.1. Note: There is typically residual dry ice in the collection cup mixed in with the oil. The dry ice will sublimate 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).
1.14.16. Use the round squeegee and alcohol to thoroughly clean the inside of the Separators and collection cup.
1.14.17. Both the Separator and the collection cup should be cleaned after each extraction.
1.14.18. Reassemble the Separator by reversing the steps above. The exception here is the sanitary clamps. The nuts on the sanitary clamps need to be inspected for thread wear or damage. The nuts on the sanitary clamps need to be replaced if they are worn or damaged and the nuts need to be put back on with a torque wrench at 20 lb. ft. of torque.
1.14.19. Reconnect the water lines to the cup before running another extraction to prevent dry ice buildup or damage to the collection cup cooling jacket.

1.15. Performing Maintenance Between Runs
1.15.1. Remove extracted material from Extraction Vessels.
1.15.2. Thoroughly clean Separation Vessel with alcohol or selected cleaning agent.
1.15.3. Clean Separator Outlet lines running from Separator 1 and Separator 2 to Separator 3.
   1.15.3.1. Disconnect the outlet lines from Separator 1 and Separator 2 and the inlet line on Separator 3.
   1.15.3.2. Open "Separator Line Cleanout Valve" located under the control panel towards the bottom, between Valves 8 and 12.

1.15.3.3. Close Valve 10A and Valve 10B.
1.15.3.4. Go to the "Manual Screen" and select “Clean Sep 1 Tubing” or “Clean Sep 2 Tubing” (Both will need to be done).
1.15.3.5. Use provided squeeze bottle to flush cleaning agent through both the Separator outlet tube selected and Separator 3s inlet tube until it runs clear out of the Separator Line Cleanout Valve.

1.15.3.6. Blow out tubing with compressed air by blowing down one tube and placing finger over the end of the other tube, as shown below in Figure 13. Switch tubes and repeat.

![Figure 13. Example of how to properly blow out separator lines after cleaning](image)

1.15.3.7. After line is clean, switch to other Separator on “Manual Screen” and repeat steps 5 and 6.

1.15.3.8. When done, select “End Sep Tube Cleaning” on “Manual Screen.”

1.15.4. Clean CO₂ return line to Diaphragm Compressor.

1.15.4.1. Ensure Valve 11 is open.

1.15.4.2. If Valve 11 isn’t open, then go to the Manual Screen and hit Evacuate. This will open Valve 11 (Evacuate will not appear on "Manual Screen" if any pressure is present in the extraction system. Go to “I/O Screen” to see where pressure is located and vent by either reassembling and recovering or loosening fitting 90 degrees and bleeding off pressure).

1.15.4.3. Disconnect the separator outlet line from the cap of Separator #3, as shown below in Figure 14.
1.15.4.4. Remove the bottom of the filter assembly and the DC filter element located on the front of the diaphragm pump, as shown below in Figure 15.

1.15.4.5. Inspect filter element for clogging or wear and replace as necessary.

1.15.4.6. Pour alcohol into the Separator outlet line until the solvent is colorless coming out of the filter. Then, use compressed air to blow out the line, ensuring that no residual alcohol remains in the line between the Separator and the pump.

1.15.4.7. Reconnect the Separator outlet line and DC filter and housing, being sure to not pinch filter O-ring (if the O-ring is swelled, replace with another O-ring).

1.15.4.8. The CO\textsubscript{2} return line must be cleaned after each extraction.

1.15.5. Reassemble Separators.
1.16. **Recommended Operating Parameters**

1.16.1. Recommended parameters are intended as a starting point to be used in conjunction with the data sheet as shown on page 38 to dial in for individual application.

1.16.2. For lighter color and less wax content
   
   1.16.2.1. Orifice Selection: #37
   
   1.16.2.2. Separator Pressure: 350-380-psi
   
   1.16.2.3. Separator Chiller Setting: 64°F
   
   1.16.2.4. Extractor Target Pressure: 1100-1300-psi
   
   1.16.2.5. Extractor Chiller/Heater Setting: 70°F
   
   1.16.2.6. Extraction Time: 1-2 hours per pound

1.16.3. For decrease in extraction time, darker and more wax content

   1.16.3.1. Orifice Selection: #18
   
   1.16.3.2. Separator Pressure: 300-320-psi
   
   1.16.3.3. Separator Chiller Setting: 74°F
   
   1.16.3.4. Extractor Target Pressure: 4000-4200-psi
   
   1.16.3.5. Extractor Chiller/Heater Setting: 110°F
   
   1.16.3.6. Extraction Time: 15-30 min per pound

2. **Troubleshooting**

2.1. Ice On Separator

   It is normal for the caps, clamps and flexible metal lines on the Separator to form ice during operation. If ice is forming on the outside of the Separator Vessels, this is an indication that there is no flow inside the Separator-Cooling Jacket. The system should be shut down by pressing the, "Recover CO₂" button on the Manual Screen. This will put the system into recovery mode so that the cooling system can be inspected.

   Ensure 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 200-400-psi. Also, ensure that the temperature of the surrounding environment is no colder than 50°F. It is possible for the chiller/heater to have difficulty maintaining system temperatures if the surrounding environment is too cold.

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

2.2. Low Extractor Pressure

   If the extractor pressure is unable to meet the target pressure, first verify that the CO₂ cylinder has sufficient CO₂, over 400-psi. If cylinder pressure is over the required pressure, verify the correct orifice is in the selected Separator and verify that both pumps are functioning correctly. The orifice
can be checked by going to the “Manual Screen,” selecting “Service Separator” and following the instructions below:

2.2.1. From the Home Screen, press the Manual Screen button.
2.2.2. From the Manual Screen, press the Service Separator button.
2.2.3. Wait for the system to provide a message pop-up indicating it is safe to Open Valve 10 and clean the orifice.
2.2.4. Open Valve 10A or Valve 10B, depending on which Separator is selected.
2.2.5. Verify that both the Separator intended to be serviced and Separator 3 vessel gauges read zero.
2.2.6. Completely remove all the flexible metal lines from the top of the Separators as described in Section 1.14. Use two wrenches to prevent bending any tubes, as shown in Figure 10.
2.2.7. Remove the yellow wire connected to the thermocouple.
2.2.8. Use the 5/8-in ratchet wrench to remove the high-pressure sanitary clamps from the top of Separator.
2.2.9. Remove the cap from the top of Separator.
2.2.10. Ensure you are using the correct size orifice and inspect for clogs.
2.2.11. Remove the orifice from the orifice tube using two wrenches to prevent bending tubing.
2.2.12. Clean the orifice by soaking it in alcohol and blowing it out with compressed air. Verify the orifice is clear by looking through it.
2.2.13. Reassemble the orifice.
2.2.14. Replace the Separator cap and tighten the clamp bolts. Tighten to 20 lb. ft. with a torque wrench.
2.2.15. Reinstall the flexible metal hoses and the thermocouple connection.
2.2.16. Close Valve 10A and Valve 10B.
2.2.17. Press the pop-up message button when orifice is reinstalled, the high-pressure clamps are tight and the flexible hoses are reconnected.

2.3. Extractor Overpressure – Orifice Clog, or Orifice is too small
The valve-less expansion technology uses an orifice to regulate pressure. This orifice can become plugged when foreign material enters 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 above to clear a clog or replace orifice.

2.4. Low Separator Pressure – Orifice Clog, or Orifice is too small
Low Separator pressure is typically caused by one of two things (an orifice clog or installation of the wrong size orifice installed). If the system has been operating with the current orifice and consistently maintained Separator pressure between 250-psi and 400-psi, this suggests that the orifice is clogged. To correct an orifice clog, refer to the instructions in the section above (2.2 Low Extractor Pressure).

2.5. High Separator 1 or 2 Pressure (>350-psi) and Low Separator #3 Pressure
High Separator 1 or Separator 2 pressure can be cause by excess oil, dry ice or a valve not functioning correctly. Follow the steps below to clean lines between the Separators:
2.5.1. From the Home Screen, press the Manual Screen button.
2.5.2. From the Manual Screen, press the "Service Separator" button.
2.5.3. Wait for the system to provide a message pop-up indicating it is safe to open Valve 10 and clean the orifice.
2.5.4. Open Valve 10A or Valve 10B, depending on which Separator is selected.
2.5.5. Verify that both the Separator intended to be serviced and Separator 3 vessel gauges read zero.
2.5.6. Completely remove all the flexible metal lines from the top of the Separators as described in Section 1.14. Use two wrenches to prevent bending any tubes.
2.5.7. Open the Separator Line Cleanout Valve located between Valve 8 and Valve 12.
2.5.8. Thoroughly clean the metal lines with alcohol to remove any debris that might be clogging the lines.
2.5.9. Blow the metal hoses out with compressed air to verify the clog has been removed.
2.5.10. Reinstall the flexible metal hoses.
2.5.11. Close Valve 10.
2.5.12. Press the pop-up message button when orifice is reinstalled, the high-pressure clamps are tight and the flexible hoses are reconnected.

2.6. Oil carryover from Separator 1 to Pump

2.6.1. Oil carryover can be detected during every maintenance run when cleaning the Separator 2 outlet to pump inlet and when spot-checking Separator 2. 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.

2.6.2. Causes:

2.6.2.1. Separator temperatures are above 40°F after system is equalized, usually occurs 1 hour after the system has started. 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 40°F.

2.6.2.2. Extremely 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.

2.6.3. Clean by performing normal maintenance between runs.
3. System Maintenance
Maintenance on the system is critical to proper operation. Failure to follow these maintenance items can cause premature system failure and void the warranty.

This maintenance schedule is based on the maintenance timer on the Maintenance Screen (see Appendix A, page 23).

3.1. Extraction System/Storage Tank Maintenance
We include a small squeeze bottle to help with proper maintenance and cleaning of your system’s CO₂ lines, as shown below in Figure 16. We recommend alcohol to clean the lines. Please label the bottle accordingly.

![Figure 16. Front and back of chemical squeeze bottle](image)

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Maintenance Item</th>
</tr>
</thead>
<tbody>
<tr>
<td>After Each Extraction</td>
<td>• Remove extracted oil from collector cup and Separator walls, clean walls and cup with alcohol.</td>
</tr>
<tr>
<td></td>
<td>• Check Separator 3 for oil carryover and clean if necessary.</td>
</tr>
<tr>
<td></td>
<td>• Inspect Separator gaskets and grooves prior to reassembly.</td>
</tr>
<tr>
<td></td>
<td>• Clean piping between Separators 1, 2 and 3 with alcohol.</td>
</tr>
<tr>
<td></td>
<td>• Clean Separator 3 CO₂ outlet to pump inlet, ensure Valve 11 is open.</td>
</tr>
<tr>
<td></td>
<td>• Remove spent material from the Extraction Vessel by vacuuming it out through the top flange. Be careful not to damage temperature probe.</td>
</tr>
<tr>
<td></td>
<td>• Verify the extractor filters are clear and free of debris.</td>
</tr>
<tr>
<td></td>
<td>• Check Extraction Vessel cup seals and cup seals groove sealing surfaces for damage – replace if necessary.</td>
</tr>
<tr>
<td></td>
<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 to not seal properly or damage the cup seal.</td>
</tr>
<tr>
<td>Every 80 Hours</td>
<td>• Check chiller/heater water level is between min. and max line on back of the chiller.</td>
</tr>
<tr>
<td></td>
<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>
</tr>
<tr>
<td>Yearly</td>
<td>• Vent Storage Tanks and Clean (Recommended to vent and clean tanks))</td>
</tr>
</tbody>
</table>
3.2. 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.</td>
</tr>
<tr>
<td></td>
<td>• Check oil pressure.</td>
</tr>
<tr>
<td></td>
<td>• Listen for abnormal noise or vibration.</td>
</tr>
<tr>
<td></td>
<td>• Check Leak Detection System status.</td>
</tr>
<tr>
<td>Every 500 Hours</td>
<td>• Change Diaphragm Compressor Filter located on suction side tubing.</td>
</tr>
<tr>
<td></td>
<td>• Check belt tension (See Appendix B, page 28).</td>
</tr>
<tr>
<td></td>
<td>• Clean process check valves.</td>
</tr>
<tr>
<td>Every 1500 Hours</td>
<td>• Perform regular oil change.</td>
</tr>
<tr>
<td></td>
<td>• Check torque on all screws in electrical panels (see Appendix D, page 32).</td>
</tr>
<tr>
<td>Every 4000 Hours</td>
<td>• Replace diaphragms and O-rings in process head.</td>
</tr>
<tr>
<td></td>
<td>• Clean and inspect oil inlet check valve.</td>
</tr>
<tr>
<td></td>
<td>• Clean and inspect oil relief valve.</td>
</tr>
<tr>
<td></td>
<td>• Inspect crankcase assembly.</td>
</tr>
<tr>
<td></td>
<td>• Inspect compressor lower head.</td>
</tr>
<tr>
<td></td>
<td>• Clean and inspect injection pump assembly.</td>
</tr>
</tbody>
</table>

3.3. Liquid Pump Maintenance
See Liquid Pump 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>Monthly</td>
<td>• Check gear oil level and add oil as required.</td>
</tr>
<tr>
<td></td>
<td>• Check front piston housing for oil.</td>
</tr>
<tr>
<td>Every 2500 Hours</td>
<td>• Change gear oil and clean magnetic filter.</td>
</tr>
<tr>
<td></td>
<td>• Inspect and clean check valves as needed.</td>
</tr>
<tr>
<td>Every 4000 Hours</td>
<td>• Check/Replace Pump Packing.</td>
</tr>
</tbody>
</table>

Appendix A.
System Screen Shots and Descriptions

A. Screen Shots
A.1 Home Screen
- The home screen is where all pressures, temperatures, run times, weight, and access to other screens are located. This is where you will enter your parameters and start your extractions.
### A.2 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 17. Home Screen**

<table>
<thead>
<tr>
<th>Extractor PSI (Degrees F)</th>
<th>Separator PSI / Degrees F</th>
<th>Storage PSI / Degrees F</th>
</tr>
</thead>
<tbody>
<tr>
<td>A 0 / 0</td>
<td>1 0 / 0</td>
<td>0 / 0</td>
</tr>
<tr>
<td>B 0 / *</td>
<td>2 0 / 0</td>
<td></td>
</tr>
<tr>
<td>Ext</td>
<td>PSI1</td>
<td>PSI2</td>
</tr>
<tr>
<td>Enter hours of cycle time</td>
<td>Enter phase 1 separator selection</td>
<td></td>
</tr>
<tr>
<td>8 Hours Selected</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**MANUAL CONTROL SCREEN**

- Leave Service Step Mode
- Open Extractor Vessel
- Evacuate Loop 1
- Change CO2 Bottle
- Evacuate Loop 2
- Recover CO2
- Tank Evac
- Reset Diaphragm Ruptured
- Reset Oil Pressure Last
- Reset Water Flow Last
- Reset VFD Fault
- E-Stop Reset
- MASTER RESET
- Not in Cycle
- Manual Flow Reversal Mode
- Go to Manual Flow Reversal
- Reverse Flow
- Switch To Separator 1
- Start Compressor Prime
- Stop Compressor Prime
- Switch To Separator 1
- Start Compressor Prime
- Stop Compressor Prime
- Go To Home Screen
- Lamp Test
- Go To Auto Mode
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.

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 CO₂ before the entered run time is complete, opening the Extractor Vessel, or changing a CO₂ bottle.

The yellow buttons for “reset” of water flow lost, oil pressure lost, VFD fault, Diaphragm ruptured, or E-Stop will only be visible when the corresponding abnormal condition exists. If there’s a fault or the system won’t start, user should check here for reset buttons and check the alarm screen for information about faults.

**A.3 Maintenance Screen**

The Maintenance Screen is rarely used. The Maintenance screen is where you will go to monitor run times on your system and pump for scheduling maintenance.
A.4 Logo Screen

- The Logo Screen is rarely used. The reason for the Logo Screen is to hide any potentially secret parameters on the Home Screen or for photo opportunities.
- Additionally, the system's software version is located on the lower left hand edge of this screen.

![Logo Screen](image)

**Figure 20. Logo Screen**

A.5 I/O Status Screen

- The I/O Status 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 temperatures as well as air and CO$_2$ pressures in PSI.
A.6 VFD (Variable Frequency Drive) Screen

- The VFD screen displays the values that are being sent to the VFD that controls the speed of the liquid pump.

A.7 Alarm Screen

- The Alarm Screen is used for troubleshooting and where navigation to the Email Messaging Screen is located. When the system faults for any reason, it is recorded on the Alarm Screen. Often the fault you see on the home screen may have been caused...
by a series of faults. By looking at the alarm screen, you can see all the previous faults in the order they occurred.

Figure 23. Alarm Screen
Appendix B.
Belt Tension Testing/Adjusting

WARNING
FOLLOW YOUR REQUIRED SAFETY PROCEDURES FOR LOCKOUT/TAGOUT STEPS BEFORE PERFORMING THIS WORK

- Remove belt guard.

- Check belt(s) tension with belt tension tester. PDC-4 belts should be tensioned to 10 lbs. and PDC-3 belts should be tensioned to 6-7 lbs.
  - If you need help using your tension tester tool, please view the following video:
  - https://www.youtube.com/watch?v=bYEHvfo8t6A
If the belt needs to be adjusted, loosen the 4 bolts holding the motor to the base, as shown below in Figure 26.

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), as shown above in Figure 26.

Alter the adjustment bolts on the motor base in or out to tighten or loosen the bolt as necessary, as shown below in Figure 27.

Be sure to check motor shaft alignment (Note: There can be up to 1/8" difference from side-to-side).
Retighten motor bolts.
Rotate belt by hand around one turn (failure to do so could result in incorrect reading).
Check belt tension again and repeat as necessary.

Appendix C.
Diaphragm Pump Priming Instruction
Open the over pump bypass valve (see Figure 29 above) by turning counterclockwise until it stops.

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

When pump is priming, verify there is oil pressure on the pump gauges. If no pressure appears, check oil level and pump motor rotation. The rotation of the motor should follow the direction of the yellow arrow on top of the belt guard.

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

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

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

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

- Fuse Holders (1492-H6) = 7.1 lb-in
- Power Supply (1606-XLE120E) = 7 lb-in
- Terminal Blocks (1492-J4) = 9 lb-in
- Ground Blocks (1492-JG4) = 9 lb-in
- Ground Block Middle Screw (1492-JG4) = 7.1 lb-in
- JG10 Large Ground Blocks (1492-JG10) = 20.4 lb-in
- JG10 Large Ground Block Middle Screw (1492-JG10) = 8.9 lb-in
- Small Motor Contactor Phillip Screws (100-C55D10) = 31 lb-in
- Small Motor Contactor (43-44) Phillip Screws = 13 lb-in
- Overload Relay (T1/T2/T3) Phillip Screws = 22 lb-in
- Overload Relay (95-98) Phillip Screws = 5 lb-in
- Large Motor Contactor Allen Screws (100-C72D10) = 53 lb-in
- Large Motor Contactor Phillips Screws (100-C72D10) = 13 lb-in
- Overload Relay Allen Screws (193-EEGE) = 40 lb-in
- Overload Relay Phillips Screws (192-EEGE) = 5 lb-in
- Micro 850 Power Supply = 4.4 lb-in
- Micro 850 Terminal Strip = 4.4 lb-in
- 2080 TC2 = 2.21 lb-in
- 2080 IF4 = 2.21 lb-in
- 2080 IF2 = 2.21 lb-in
- HMI = 5 lb-in
- Yellow Terminal Jumpers = 7.1 lb-in
- Estop Contact (800F-X01) = 8 lb-in
- Relay Base Screws (700-HN153) = 7 lb-in
- IF8 = 5.3 lb-in
- Relay Output Module = 5.3 lb-in
- 10A Circuit Breaker (18 AWG) = 13.3 lb-in
- 10A Circuit Breaker (14 AWG) = 17.7 lb-in
- 10A Circuit Breaker (8 AWG) = 39.9 lb-in
- Ewon Flexy Power Connector = 7 lb-in
- Ewon Cosy Power Connector = 7 lb-in
- 125V Plug = 12 lb-in
Appendix E.
Piping and Instrumentation Diagram
Appendix F.
CO$_2$ Phase Diagram
Appendix G.
Pre-Training Checklist
<table>
<thead>
<tr>
<th>Run #</th>
<th>External Variables</th>
<th>Input Variables</th>
<th>Output Variables</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Start Time</td>
<td>Facility Temp</td>
<td>Facility Humidity</td>
</tr>
<tr>
<td></td>
<td>Facility Designator</td>
<td>Botanical Weight</td>
<td>Botanical Weight</td>
</tr>
<tr>
<td></td>
<td>Orifice Size</td>
<td>Chiller Set Point</td>
<td>Extractor Target Pressure</td>
</tr>
<tr>
<td></td>
<td>Extractor Target Pressure</td>
<td>Target Run Time</td>
<td>Extractor Temp</td>
</tr>
<tr>
<td></td>
<td>Separator Temp</td>
<td>Separator Pressure</td>
<td>Oil Weight</td>
</tr>
<tr>
<td></td>
<td>Oil Weight</td>
<td>Water Weight</td>
<td></td>
</tr>
</tbody>
</table>
References

YouTube Instructional Videos
https://www.youtube.com/channel/UCzo7qXTIt01wfoKB2b9EO-g

Apeks Online Store
http://www.apekssupercritical.com/online-store/