Co-solvent Oil Extraction System
Installation and Operation Manual
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# Table of Contents

1. Critical Safety Overview .......................................................................................................................... 4
2. Facility Requirements ......................................................................................................................................... 6
   Temperature ......................................................................................................................................................... 6
   Ventilation and Dust Control ............................................................................................................................ 6
   Foundation .......................................................................................................................................................... 6
   Custom Layout .................................................................................................................................................... 6
3. When the System Arrives ................................................................................................................................. 7
   Verifying Apeks System Contents List .............................................................................................................. 7
   Receiving the Crates .......................................................................................................................................... 8
   Apeks Labeling ................................................................................................................................................ 8
   TiltWatch and ShockWatch ............................................................................................................................... 9
   Inspecting Crates for Damage ........................................................................................................................... 9
   System Layouts .................................................................................................................................................. 10
   Unpacking Instructions ...................................................................................................................................... 16
   Uncrating Co-solvent Stand and CO₂ Flowmeter .............................................................................................. 16
   Setup and Assembly ......................................................................................................................................... 17
   Ethanol Module and CO₂ Flowmeter Connections .......................................................................................... 17
   Electrical Requirements .................................................................................................................................. 27
   Electrical Connections and Wiring ..................................................................................................................... 28
   E-mail Alerts and Software Updates ................................................................................................................ 30
4. General Overview and Nomenclature ............................................................................................................. 30
   System Overview .............................................................................................................................................. 30
   Co-solvent Component Overview .................................................................................................................. 30
   General System Specifications ......................................................................................................................... 35
5. Operations ....................................................................................................................................................... 36
   Initial Startup ................................................................................................................................................... 36
   Prepping the Separator for a Co-solvent Run ................................................................................................. 36
   Pulling a Vacuum with the Co-solvent Module ............................................................................................... 39
   Emptying the Collection Vessel ....................................................................................................................... 39
   Filling the Ethanol Tank .................................................................................................................................. 39
   Configuration and Run Screens ...................................................................................................................... 40
   Operation Modes ............................................................................................................................................ 41
   Operating Instructions ................................................................................................................................... 41
   Estimate Ethanol Usage .................................................................................................................................. 42
6. System Preventative Maintenance .................................................................................................................. 42
   CO₂ Flowmeter ............................................................................................................................................... 42
   CO₂ Flowmeter Flange Tightening for O-Ring Replacement ......................................................................... 43
   Ethanol Filter .................................................................................................................................................... 43
   Ethanol Tank .................................................................................................................................................... 43
   Ethanol Flowmeter ......................................................................................................................................... 44
   Pump Maintenance ......................................................................................................................................... 45
7. Troubleshooting ............................................................................................................................................. 46
   System Messages and Alarms .......................................................................................................................... 46
   Other Symptoms ............................................................................................................................................ 49
8. References ...................................................................................................................................................... 51
9. Appendices ..................................................................................................................................................... 52
   Appendix A: Torque Requirements .................................................................................................................. 52
1. Critical Safety Overview

Please read these important safeguards carefully before installing, operating or performing any user-maintenance activities on the system, and save these instructions to refer to them as needed to ensure continued safe operation. These instructions are critically important to your safety and proper operation of the system. Failure to follow these instructions may result in damage to equipment and/or bodily injury.

- Ensure that a qualified safety officer oversees all installation, operation and user-maintenance activities in accordance with this instruction manual.

- Ensure that only qualified personnel perform all installation, operation and user-maintenance activities in accordance with this instruction manual.

Note: Qualified personnel are given documented training and should be qualified by the extractor manufacturer or its designee, or as otherwise required by the Authority Having Jurisdiction (AHJ), prior to performing any installation, operation or user-maintenance activities. Qualified personnel are to be experienced in such work and must be aware of and take all safety precautions.

- Our subcritical and supercritical CO2 extraction systems operate under high pressure. Operators must be fully trained and familiar with the systems. Failure to operate these systems correctly can result in a rapid release of high-pressure CO2 and may cause equipment damage and/or bodily injury.

- Our subcritical and supercritical CO2 extraction systems use large amounts of CO2 during operation. These systems should be installed in a well-ventilated area to prevent buildup of CO2, which can cause asphyxiation. Always use a CO2 monitor to ensure safe operations.

  WARNING – RISK OF INJURY: Opening a vessel under pressure can result in a rapid release of pressure and ejection of material from 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 gauge reads zero prior to loosening the vessel closure. If the handles are difficult to open, this may indicate that the pressure vessel is still pressurized. Do not force it open. Any pressure in the pressure vessel can be hazardous.

  WARNING – MAY CAUSE BURNS: Liquified gases are normally stored under pressure. When these liquids are released to atmospheric pressure, rapid evaporation occurs resulting in reduced temperatures at the point of evaporation. Exposure of tissue to evaporating liquid can result in freezing and tissue damage. Precautions should be taken to avoid contact of liquid with eyes, skin, or respiratory system. Tissue damaged by exposure to evaporating liquid should be treated as frozen tissue (i.e., frostbite). Reference the Safety Data Sheet (SDS) for more detailed information.

  WARNING – RISK OF INJURY: Check that all components are secured before operating the extraction system.

- Our subcritical and supercritical CO2 extraction systems are designed to operate indoors in a temperature-controlled environment. Extreme temperatures (below 60°F and above 80°F) will negatively impact the functionality of the system, chiller, pump and CO2 bottles.

- For indoor chiller and cooling system applications, only use propylene glycol and distilled water. Never use deionized water in the chiller or cooling system for indoor applications. For outdoor chiller and cooling system applications, use propylene glycol and clean tap water.
• Extraction system components can weigh in excess of 2,000 lb. and must be moved carefully. **Do not attempt to move system pieces without the proper equipment, as this could result in serious injury or death.**

• Personal Protective Equipment (PPE) is recommended for persons during setup, operation, disassembly, and clean-up of the equipment. It is recommended that operators wear the following PPE:
  - Chemical-resistant safety goggles;
  - Gloves;
  - Ear protection devices;
  - Flame-resistant clothing (when working with flammable solvents or in an otherwise hazardous location);
  - Close-toed foot protection; and
  - Respirator mask.

• For CE Code-based installations and NEC-based installations, please refer to the following instructions, as applicable:
  - For CE Code-based installations: “Installations shall be in accordance with the manufacturer’s installation instructions and CSA C22.1, Canadian Electrical Code, Part 1 (CE Code), National Fire Code of Canada (NFC), and CSA B149.1, Natural Gas and Propane Installation Code.”
  - For NEC-based installations: “Installation shall be in accordance with the manufacturer’s installation instructions and NFPA 70, National Electrical Code (NEC), International Fire Code (IFC), NFPA 1, Fire Code, and NFPA 58, Liquified Petroleum Gas Code.”

• It is the responsibility of the AHJ to verify the suitability of the extractors in the end installation in accordance with all applicable codes, together with these installation instructions.

• **WARNING – RISK OF EXPLOSION:** Flammable solvents being used. Avoid open flames, smoking materials, electrical sparks, and static electricity.

• For use only with 180-200 proof ethanol.

**FAILURE TO FOLLOW THE INSTALLATION AND OPERATION PROCEDURES PROVIDED IN THIS MANUAL MAY VOID THE EXTRACTION SYSTEM’S WARRANTY.**
2. Facility Requirements

Temperature

The co-solvent system is designed to run in a climate-controlled facility where the temperature is maintained between 60°F and 80°F. System performance will decrease outside this temperature range, getting progressively worse as temperatures deviate farther from the recommended range.

Ventilation and Dust Control

The co-solvent system should be placed in a well-ventilated environment that is free from excess dust from other manufacturing operations. Processing areas shall include a hazardous exhaust system designed to maintain flammable liquid vapors in normal operations and in an upset condition to below 25% of the applicable lower flammability limit (LFL). The hazardous exhaust system must continuously operate when flammable liquids are used within the processing area and shall be interlocked with the operation of the extraction equipment located within the processing area so that the equipment cannot be operated unless the ventilation is in operation. A minimum of 76 cfm is recommended.

Foundation

The co-solvent system is designed to be installed on a concrete (or similarly stable) flat floor.

Custom Layout

The co-solvent system is designed to be able to be in different rooms or areas to isolate different portions of the process. This modulation should be stated during the purchase process, otherwise additional costs and delays may occur.
3. When the System Arrives

Verifying Apeks System Contents List

Every Apeks machine is sent with a system contents list that contains a quality control checklist and a packing slip, such as the one shown in Figure 3-1.

VERIFY THAT ALL ITEMS ON THE PACKING SLIP HAVE BEEN RECEIVED BEFORE CONTINUING WITH UNPACKING AND INSTALLATION. CONTACT US IF ANY ITEMS ARE MISSING.

![Figure 3-1: Packing Slip](image-url)
Receiving the Crates

Apeks Labeling

An Apeks sticker (such as the one shown in Figure 3-2) should be displayed on the outside of each crate. If the crate delivered to you does not have an Apeks sticker, please contact us to ensure the crate came directly from Apeks.

![Shipping Label](image-url)

**Figure 3-2: Shipping Label**
**TiltWatch and ShockWatch**

Each crate should have TiltWatch Plus sensors and ShockWatch stickers (such as those shown in Figure 3-3) affixed on the outside. The TiltWatch Plus Sensors indicate the degree to which the crate may have tilted to the right or left or if the crate overturned completely during shipping. If the sensors show the crate tilted beyond 30° to the right or left or overturned completely, please contact us. The ShockWatch sticker is an additional sticker that indicates if the crate has been mishandled. If the indicator on the ShockWatch sticker is red, please contact us.

![TiltWatch Label and ShockWatch Sticker](image)

*Figure 3-3: TiltWatch Label and ShockWatch Sticker*

**Inspecting Crates for Damage**

Prior to opening any crate, you should verify that there is no visible external damage. If you notice your crate has been damaged, be sure to note the damage on the applicable Proof of Delivery, and please contact us to report the damage.
System Layouts

The Force® 2ST 5000psi Standard Layout
(20Lx20L shown)
The Force® 2ST 5000psi Floor Layout
(20Lx20L shown)
The Duplex® 2000psi Floor Layout
(20Lx20L shown)
The Transformer® 2000psi Floor Layout
(5Lx5L shown)
Unpacking Instructions

⚠️ **WARNING**: Each crate contains heavy components. Do not attempt to lift without the proper equipment.

Uncrating Co-solvent Stand and CO₂ Flowmeter

To uncrate the co-solvent and CO₂ flowmeter stands, first, remove the sides and top of the shipping crates. Then, remove the wooden tie downs that keep the stand and flowmeter attached to the skid. See Figure 3-4. Remove the flowmeter from the crate by lifting it up from its stand. Using a forklift or the provided ramp, remove the stand from the skid and attach leveling feet. Place the stand in its final location with the supplied spill containment tray underneath.

![Figure 3-4: Co-solvent Wood Tie-Downs Shown](image-url)
Setup and Assembly

Ethanol Module and CO₂ Flowmeter Connections

Place the co-solvent module to the left of the extractor and the CO₂ flowmeter between the separator stand and pump. Co-solvent modules are sent with a 27-gallon spill-control tray. They co-solvent module should be placed in this tray to contain any ethanol leaks.

Duplex Layout

![Diagram of Duplex Layout](image-url)
Once the co-solvent module is in place, attach the supplied hose between the outlet port on the co-solvent stand and the inlet port on the CO₂ system as seen in the photos below. Note that for the Duplex and Force systems there will be two connection ports on the CO₂ system.
Place CO₂ flow meter between the separator and the pump as shown below. Disconnect one end of the suction side hose running from the CO₂ system to the diaphragm compressor and reconnect to the CO₂ flow meter based on which side you disconnected. Use the supplied hose to connect the other side of the flow meter to the remaining component.
Electrical Requirements

**WARNING**: Do not modify power connections.

### Electrical Specifications:

**Co-Solvent Injection Module**

<table>
<thead>
<tr>
<th>Co-Solvent Pump Motor HP</th>
<th>Phase</th>
<th>Voltage</th>
<th>Motor FLA</th>
<th>Recommended Fuses where field wired</th>
<th>System</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>208V</td>
<td>8.8A</td>
<td>AJT15</td>
<td>The Transformer®/The Duplex®</td>
</tr>
<tr>
<td>1</td>
<td>3</td>
<td>208V</td>
<td>4.6A</td>
<td>AJT8</td>
<td>The Transformer®/The Duplex®</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>230V</td>
<td>8A</td>
<td>AJT14</td>
<td>The Transformer®/The Duplex®</td>
</tr>
<tr>
<td>1</td>
<td>3</td>
<td>230V</td>
<td>4.2A</td>
<td>AJT8</td>
<td>The Transformer®/The Duplex®</td>
</tr>
<tr>
<td>1</td>
<td>3</td>
<td>460V</td>
<td>2.1A</td>
<td>AJT4</td>
<td>The Transformer®/The Duplex®</td>
</tr>
<tr>
<td>5</td>
<td>3</td>
<td>208V</td>
<td>16.7A</td>
<td>AJT30</td>
<td>The Force®</td>
</tr>
<tr>
<td>5</td>
<td>3</td>
<td>230V</td>
<td>15.2A</td>
<td>AJT26</td>
<td>The Force®</td>
</tr>
<tr>
<td>5</td>
<td>3</td>
<td>460V</td>
<td>7.6A</td>
<td>AJT13</td>
<td>The Force®</td>
</tr>
</tbody>
</table>

*Recommended motor branch circuit fuse protection is 175% of NEC FLA from Table 430-250 per 430.52. Explanation here: [http://www.cooperindustries.com/content/dam/public/bussmann/Electrical/Resources/solution-center/technical_library/BUS_Ele_Tech_Lib_Motor_Circuit_Notes.pdf](http://www.cooperindustries.com/content/dam/public/bussmann/Electrical/Resources/solution-center/technical_library/BUS_Ele_Tech_Lib_Motor_Circuit_Notes.pdf)
Electrical Connections and Wiring

**Co-solvent Ethanol Pump Motor Wiring**
The provided 30’ SOOW cord coming from the top of the co-solvent enclosure will be used to power your co-solvent ethanol pump. Have a licensed, commercial electrician, wire the co-solvent pump to your facility electric.
Other Connections

- For Duplex/Force Systems Only: Plug the co-solvent system enclosure into a 110-V, 15-A, standard outlet. Use a surge protector for the co-solvent enclosure.
- Connect the yellow cable coming from the bottom of the co-solvent enclosure to your co-solvent system’s CO₂ Flow Meter. The yellow cable has an M12 connection that mates with an M12 port on the CO₂ Flow Meter.

- Connect the included ethernet cable to the RJ45 port on the side of the co-solvent enclosure as well as the newly added RJ45 port on the Main Control Enclosure.
E-mail Alerts and Software Updates

To receive software updates and e-mail alerts, connect your system to the Internet by attaching an Ethernet cable to the Ethernet connection located on the side of the electrical control box. After you have connected your system to the Internet, you can sign up for e-mail alerts. To do so, please visit https://www.apekssupercritical.com/service-request/ and submit a ticket with your system’s information. One of our representatives will contact you once e-mail messaging has been set up, and you can then decide which notifications you wish to receive via the “Message Selection” screen. When setting up e-mail messaging, you can also choose to set up daily data logs.

4. General Overview and Nomenclature

System Overview
This section is intended to provide a general overview of the system and to showcase the various components.

Co-solvent Component Overview

1. Ethanol Tank: Storage tank to hold a maximum of 25 gallons of 180-200 proof ethanol.
2. Ethanol Flow Meter: Flowmeter to read the ethanol flowrate being pumped into the system.
3. Ethanol Pump: Liquid pump used to deliver ethanol to the system. Pump model will depend on extraction system being used.
4. Ethanol Filter: Filter placed before the Ethanol Pump to prevent any large debris from entering the pump.
5. Pressure Relief Valves: Valves used to prevent the system from over pressurizing and causing damage to equipment and potential safety risks.
6. Manual Ball Valves:
   a. Purge Valve: Valve used to prime the ethanol pump. This valve is closed during normal operation.
   b. Ethanol Tank Isolation Valve: Valve used to isolate the Ethanol Tank from the rest of the system.
   c. Drain Valve: Valve used to remove ethanol from the Ethanol Tank (gravity drain).
   d. Outlet Valve: Valve to CO2 System.
7. Pressure Gauge: Gauge to monitor the pressure coming out of the Ethanol Pump and into the extraction system.
8. Controls Enclosure: Enclosed box to house all electrical components.
9. CO2 Flowmeter: Flowmeter to read the CO2 flowrate throughout the system.
10. Co-solvent Collection Vessel: External vessel to increase the volume of the collection cup.
2000 psi Model

- Controls Enclosure
- Ethanol Tank
- Pressure Relief Valve
- Fill Port
- Level Sensor
- Outlet Port
5000 psi Model
(same as 2000psi model except for the following)

5000 psi Ethanol Pump
# General System Specifications

<table>
<thead>
<tr>
<th></th>
<th>Transformer Module</th>
<th>Duplex Module</th>
<th>Force Module</th>
<th>Ethanol Tank</th>
<th>CO₂ Flow Meter</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Max Pressure (psi)</strong></td>
<td>2000 psi</td>
<td>2000 psi</td>
<td>5000 psi</td>
<td>Atmospheric</td>
<td>600 psi</td>
</tr>
<tr>
<td><strong>Operating Temperature (°F)</strong></td>
<td>40°F - 120°F</td>
<td>40°F - 120°F</td>
<td>40°F - 120°F</td>
<td>20°F - 80°F</td>
<td>0°F - 100°F</td>
</tr>
<tr>
<td><strong>Dimensions (in) WxDxH</strong></td>
<td>26 x 40 x 60</td>
<td>26 x 40 x 60</td>
<td>40 x 40 x 60</td>
<td>20 x 20 x 24</td>
<td>20 x 13 x 32</td>
</tr>
<tr>
<td><strong>Weight (lb.)</strong></td>
<td>500 (Empty)</td>
<td>500 (Empty)</td>
<td>1000 (Empty)</td>
<td>N/A</td>
<td>50</td>
</tr>
</tbody>
</table>
5. Operations

Initial Startup

1. Make sure drain valve is closed
2. Using 180-200 Proof Ethanol ONLY, fill the 25-gallon capacity co-solvent tank. Ethanol should be transferred to the tanks via a pump or other method through the fill port. Ethanol should not be dumped directly into tank unless the system is completely de-energized.
3. Open Isolation valve and Purge Valve and close Outlet Valve.
4. Start Ethanol co-solvent Prime on the co-solvent Screen on the system HMI
5. Run until a steady stream of ethanol is flowing back into the ethanol tank.
6. Stop the ethanol pump from the HMI screen.
7. Close Purge Valve, open Outlet Valve.

Prepping the Separator for a Co-solvent Run

While very short co-solvent runs can be done without adding additional volume to the separator, runs over 5 minutes into the separator should be paired with a co-solvent collection vessel.

1. Remove the elbow on separator top of the outlet tube on 1A and/or 2A outlet and insert the supplied tee and elbow.
2. Replace the large collection cup with the smaller collection cup with a ball valve on the bottom. Ensure that the connection of the ball valve on the bottom of the collection cup is tight. Open the ball valve to allow flow to the co-solvent collection vessel.

3. Place the co-solvent collection vessel next to the desired separator bank and connect both the CO₂ inlet and outlet hoses and the water connections.
CO$_2$ connections on the co-solvent collection vessel.

Water connections on the co-solvent collection vessel.
Pulling a Vacuum with the Cosolvent Module

When pulling a Vacuum with the cosolvent module, follow the typical vacuum practice of your system but also close valve C2 to keep ethanol from being sucked into the system. Once the system is pressurized with CO₂, open the valve.

Emptying the Collection Vessel

To empty the collection vessel:
   1. Open valve ten and make sure separator is depressurize by verifying on HMI screen and Separator pressure gauge.
   2. Disconnect the CO₂ inlet and outlet lines from the top of the vessel.
   3. Close the coolant ball valve and disconnect the water lines.
   4. Roll the collection vessel to a location acceptable for transfer.
   5. Stand Vessel up slowly.
   6. Place container under vessel and open ball valve until vessel is empty.

Filling the Ethanol Tank

Ethanol should be transferred to the tanks via a pump or other method through the fill port.
Configuration and Run Screens

Ensure that the latest co-solvent software has been downloaded to the system. The software version can be located on the logo screen. The screens shown in Figure 5-1 and 5-2 are where the co-solvent system will be enabled and disabled. This screen will also show real time run data and other pertinent information including remaining and approximate run time until depletion of ethanol tank, ethanol flow rate and CO₂ flowrate.

![Figure 5-1: Co-solvent Screen for The Transformer and The Bambino](image1)

![Figure 5-2: Co-solvent Screen for The Duplex and The Force](image2)
Operation Modes

Duplex and Force – The Duplex and Force co-solvent Module is programmed to run three different operating modes. The first mode will run the co-solvent system only when the extraction system is running into the Bank 1 separators. The second mode will run the co-solvent system only when the extraction system is running into the Bank 2 separators. The third mode is Time Based and will start and stop based on the inputted run time. This mode will ignore which separator bank is running.

Transformer – The Transformer system co-solvent Module is Time Based and will start and stop based on the inputted run time.

Operating Instructions

Once the system is turned on, to start or stop the co-solvent module, go to the “Co-solvent Screen”, located in the screen navigation bar, click “Enable Co-solvent” to start the co-solvent module and “Disable Co-solvent” to stop. The co-solvent module will default to disable every time the system stops. Enabling the co-solvent will begin prompts for the user to select the mode and input co-solvent percentage.

Once the desired operation mode parameters are met the co-solvent pump will automatically add ethanol to the system based on the CO\textsubscript{2} flow rate and desired percentage. The ethanol is injected just before the extractor(s) in use and will flow with the CO\textsubscript{2} through the raw material to collect oil. This ethanol will travel to the separator and be collected there.

When running this co-solvent module care must be taken to ensure ethanol does not overfill separator. The co-solvent program has a totalizer in it that will stop the addition of ethanol once a certain level is met. To empty the separator:

1. Verify the separator is offline, whether the system is stopped, not running into that bank or in “Service Separator Mode.”
2. Vent any pressure through Valve 10.
3. On systems without a separate co-solvent collection vessel remove separator cap and ensure that ethanol is not above the top of the collection cup, then remove the cup and collect the ethanol/oil solution.
4. On systems with a separate co-solvent collection vessel close the Collection Valve and remove the inlet and outlet hoses from the co-solvent collection vessel.
5. Empty collection vessel.
6. Open collection valve to collect any additional solution in the separator bank.
7. Replace Collection Vessel or remove co-solvent modifications if conducting a standard run.
Estimate Ethanol Usage

<table>
<thead>
<tr>
<th>System</th>
<th>Pressure (psi)</th>
<th>Est. CO2 Flow Rate (L/min)</th>
<th>5% Ethanol Flow Rate (L/min)</th>
<th>24 Hour Usage (L) (assumed 75% run time of module)</th>
<th>24 Hour Usage (Gal) (assumed 75% run time of module)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transformer</td>
<td>1200</td>
<td>2.574</td>
<td>0.12870</td>
<td>139.00</td>
<td>36.72</td>
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<tr>
<td>Transformer</td>
<td>1800</td>
<td>1.269</td>
<td>0.06345</td>
<td>68.53</td>
<td>18.10</td>
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<tr>
<td>Duplex</td>
<td>1200</td>
<td>7.399</td>
<td>0.36995</td>
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<td>105.55</td>
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<td>Duplex</td>
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<td>3.879</td>
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<td>209.47</td>
<td>55.34</td>
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<tr>
<td>Force</td>
<td>1200</td>
<td>5.791</td>
<td>0.28955</td>
<td>312.71</td>
<td>82.61</td>
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<tr>
<td>Force</td>
<td>4000</td>
<td>4.093</td>
<td>0.20465</td>
<td>221.02</td>
<td>58.39</td>
</tr>
</tbody>
</table>

6. System Preventive Maintenance

CO2 Flowmeter
Clean the CO2 Flowmeter weekly:
1. Ensure the system is de-energized.
2. Remove both the elbow fitting and hose at the top and bottom of the CO2 flow meter.
3. Flush ethanol through the flowmeter until the exiting solution is clear.
4. Once clean, blow the tubing out with compressed air.

**CO₂ Flowmeter Flange Tightening for O-Ring Replacement**

The CO₂ flowmeter O-Rings will need to be changed as needed. The required torque required for the CO₂ flowmeter flange is 30 ft-lb for ¾” tubed flowmeters and 20 ft-lb for ½” tubed flowmeters. See below for the CO₂ flowmeter bolt pattern.

**Ethanol Filter**

Clean the Ethanol Filter monthly:
1. Ensure the system is de-energized.
2. Close Isolation Valve.
3. Place pan or container under filter to catch any alcohol in line.
4. Remove bottom filter housing.
5. Remove mesh filter screen and clean.
6. Reassemble the filter and housing.
7. Open Isolation Valve.

**Ethanol Tank**

Clean the Ethanol Tank quarterly.
1. Ensure the system is de-energized.
2. Empty the Ethanol Tank with the Drain Valve.
3. Clean and then dry the Ethanol Tank.
Ethanol Flowmeter

Confirm the flowrate annually and re calibrate if necessary.

Flow Calibration Adjustment — Rheotherm “smart” instruments use a unique algorithm, SmartSpan, to allow the user to adjust the flow instrument’s calibration. The operator may adjust the flow calibration curve at any two flow rate values. This is similar to making a zero and span adjustment, which typically involves making a zero adjustment at low or zero flow followed by a span adjustment at a high or full-scale flow value. A key feature of SmartSpan allows a two point adjustment without any interaction between the current adjustment and the previous one. Here the user should select two rates of flow to either optimize the factory calibration or to compensate for a fluid type that is different from the original calibration. There are two ways to adjust the flow rate indication

For Hazardous Locations: WARNING: DO NOT REMOVE ANY COVER WHILE CIRCUITS ARE ENERGIZED. ONLY INSTRUMENTS WITH A ‘-FM’ DESIGNATION IN THE MODEL NUMBER ARE APPROVED FOR USE IN HAZARDOUS AREAS.

For Non-Hazardous Locations: WARNING: NOT ALL MODEL 210 INSTRUMENTS ARE FOR USE IN HAZARDOUS LOCATIONS. ONLY INSTRUMENTS WITH A ‘-FM’ DESIGNATION IN THE MODEL NUMBER ARE APPROVED FOR USE IN HAZARDOUS AREAS. To perform a calibration adjustment on an instrument without a display, the transmitter housing cover must be removed to access the IR communications port and a palm device is required. Since the instrument must be active to perform this operation, follow prudent safety procedures before attempting this procedure.

CAUTION: Although the calibration adjustments can be made at any non-zero flow value, it is recommended that the low and high flows be at least 10% of full-scale apart from each other. If the desired accuracy is not met with this technique, a factory assisted recalibration may be required.

CAUTION: Adjustments to the calibration will override the factory calibration settings. Before field calibrating the unit, make sure indication errors are not correctable by reviewing the installation guidelines and making any necessary flow system changes. Note: factory calibration settings can be restored as detailed below.

a. Enable/Disable Calibration Adjustment

A separate feature of SmartSpan is the ability to disable and enable the calibration adjustment function to prevent accidental or unauthorized changes to calibration. This is done by setting both the top and bottom display lines to the ‘Temp °C’ field, then by holding a finger over the ‘Select’ proximity sensor. The message ‘SmartSpan / Disabled’ will be displayed when disabled. Change both display lines to the ‘Temp °F’ field and press ‘Select’ to enable calibration adjustment. The factory default setting will have this feature enabled.

b. Adjust Calibration Using Proximity Sensors

i. Establish flow at a known flow value near the low range of normal use (e.g., 1520% of full-scale flow). Do not attempt to zero the indication at a non flowing condition.

ii. Hold a finger over the ‘Scroll’ button until the ‘SmartSpan / Adj Low’ prompt is displayed and move to step iii before the display mode reverts back to the previous setting. Select the prompt containing a ‘8’ to increase the flow indication or a ‘9’ to decrease the flow indication.

iii. Hold a finger over the ‘Select’ button to begin. As you continue to hold the button the sensitivity will continue to increase. For fine adjustment, release the button, and continue to press and release to change the offset incrementally. Recheck the measured flow, compare with the instrument indication, and readjust as needed. Use the ‘Adj High 8’ or ‘Adj High 9’ prompts similarly at a high flow (e.g., 85-95% of full-scale flow) to complete the two point calibration.

A message of ‘Flow is too low / for Adj High’ or ‘Flow is too high / for Adj Low’ will appear during calibration if the flow is out of the allowed range for the adjustment.

c. Adjust Calibration Using Palm Device — Refer to Palm Software Appendix
d. **Restore Factory Calibration** — Restore the factory calibration settings by setting both the top and bottom display lines to the ‘Software Version’ field and then hold a finger over ‘Select’. Alternatively, using the palm ‘Calibration Adjustment’ option, tap the ‘Restore Cal’ button. By either method, the message ‘Factory Cal A[B,C,or D] / Restored’ will be displayed when completed.

**Pump Maintenance**

### 2000 psi Pump

<table>
<thead>
<tr>
<th>Pressure</th>
<th>&lt;90°F (32°C)</th>
<th>&lt;139°F (60°C)</th>
<th>&lt;180°F (82°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;1500 psi (104 bar)</td>
<td>6,000</td>
<td>4,000</td>
<td>2,000</td>
</tr>
<tr>
<td>&lt;2500 psi (173 bar)</td>
<td>3,000</td>
<td>2,000</td>
<td>1,500</td>
</tr>
</tbody>
</table>

Note: Minimum oil viscosity for proper hydraulic end lubrication is 16-20 CST (80-100 SSU). P-Series replacement parts kits (complete kits and diaphragm kits) include suitable oil for each P Series pump configuration.

**CAUTION:** If you are losing oil but don’t see any external leakage, or if the oil becomes discolored and contaminated, the diaphragm (17) may be damaged. Refer to the Fluid End Service and Troubleshooting Sections. Do not operate the pump with a damaged diaphragm.

### Periodically

**CAUTION:** Do not turn the drive shaft while the oil reservoir is empty.

**CAUTION:** Do not leave contaminated oil in the pump housing or leave the housing empty. Remove contaminated oil as soon as discovered and replace with clean oil.

1. Check inlet pressure periodically with gauge.
2. Change oil according to hours guidelines in table.
3. Change oil as follows:
   a. Remove brass cap (60), and allow oil and contaminants to drain completely. Catch oil and dispose of properly.
   b. Use suitable Hydra-Oil for the application and pump components.

### 5000 psi Pump

### 6.1 Maintenance

⚠️ **Observe section 1.4 “Safety” of this operating instruction before doing any maintenance work!**

**Weekly:** Check lubricant level in pump drive unit.

For this also refer to operating instructions of the subassemblies pump heads, stroke actuators and accessories.

Check all sealing joints for possible leaks.

Please refer to operating instruction “Pump Drive Unit” or “Stroke Actuator” for volume of lubricant.

For lubricant qualities please refer to operating instruction B 1.001 and B 1.002.

Also observe the maintenance instructions of sub-supplied assemblies such as e.g. couplings, external gears.

Depending on the ambient operating conditions (load, temperature, humidity of air, contamination of the surrounding air with pollutants) the lubricants age rather differently. Therefore lubricants should be analysed every 3-6 months, depending on the load, and replaced if they are no longer suitable.

⚠️ **Lubricants which are contaminated by chemicals will cause excessive wear, corrosion and leakages at seals.**

⚠️ **For operation in the hazardous area (except category 3 (ATEX)) the maintenance intervals stated in the operating instruction of the corresponding sub-assembly must be maintained precisely.**
### Apeks Automatic Machine Fault Troubleshooting Guide (Duplex and 2-Stage)

Never perform work on energized equipment. Always de-energize all systems to remove all forms of stored energy before performing any maintenance or repair to any system. Follow all OSHA lockout/tagout rules as well as any safety requirements specific to your local authority having jurisdiction. Only qualified personnel should attempt maintenance, repair or troubleshooting of any equipment.

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Error Type</th>
<th>Resolution</th>
</tr>
</thead>
<tbody>
<tr>
<td>F73</td>
<td>Ethanol high level fault</td>
<td>The level sensor detected an ethanol level that exceeds maximum recommended fill level in the tank</td>
<td>Tank overfilled; level sensor faulty</td>
</tr>
<tr>
<td>F74</td>
<td>Ethanol high level warning</td>
<td>The level sensor detected an ethanol level that is nearing the recommended maximum fill level in the tank</td>
<td>Tank full, level sensor faulty</td>
</tr>
<tr>
<td>F75</td>
<td>Ethanol low level warning</td>
<td>The level sensor detected an ethanol level that is nearing the recommended minimum fill level in the tank</td>
<td>Tank level low, level sensor faulty</td>
</tr>
<tr>
<td>F76</td>
<td>Ethanol low level fault</td>
<td>The level sensor detected an ethanol level below the minimum required operating level</td>
<td>Tank level low, level sensor faulty</td>
</tr>
<tr>
<td>Fault Code</td>
<td>Description</td>
<td>Cause</td>
<td>Steps</td>
</tr>
<tr>
<td>------------</td>
<td>-------------</td>
<td>-------</td>
<td>-------</td>
</tr>
<tr>
<td>F77 Ethanol temperature fault</td>
<td>Ethanol temperature thermocouple detected a fault</td>
<td>Thermocouple cable damaged, thermocouple damaged, thermocouple cable disconnected, PLC thermocouple input card damaged</td>
<td>1. Check thermocouple cable connection to thermocouple. 2. Inspect condition of thermocouple cable. 3. Inspect condition of thermocouple. 4. Swap location of two thermocouples and see if fault follows the cable or the thermocouple to aid in diagnosis. 4. Replace cable if problem follows cable. Replace thermocouple if problem follows thermocouple. 5. If thermocouple and cable are both known good parts, PLC input card is likely cause. 6. Contact Apeks</td>
</tr>
<tr>
<td>F78 Ethanol high pressure fault</td>
<td>The ethanol pump outlet pressure is near the high-pressure fault</td>
<td>Valve 44 or 45 malfunction, Outlet valve C4 closed, Faulty pressure transducer, bad pressure transducer wiring</td>
<td>1. Check air operated ball valves for operation and condition. 2. Ensure manual outlet valve C4 is open. 3. Check pressure transducer wiring and pressure transducer condition. 4. Call Apeks</td>
</tr>
<tr>
<td>F79 Ethanol VFD fault</td>
<td>The ethanol pump variable frequency drive is faulted</td>
<td>Pump overload, loss of one or more phases of voltage to drive or motor</td>
<td>1. Check display on co-solvent screen for VFD fault code. 2. Check VFD display for fault code. 3. Check power supply to pump motor VFD. 4. Check emergency stop. 5. Call Apeks</td>
</tr>
<tr>
<td>F80 Ethanol flow lost fault</td>
<td>The ethanol flow meter is detecting a loss of flow during operation</td>
<td>Ethanol pump pre-filter obstructed, outlet valve C4 is closed, valve 44 and 45 are closed (one of the two should be open), pump is faulty, flow meter is faulty.</td>
<td>1. check valve positions of C4 outlet valve, 44 and 45 to be sure C4 and one of 44 and 45 are open. 2. Check ethanol pump for operation. 3. check for flow meter power. 4. check flow meter wiring to be sure it is intact. 5. call Apeks</td>
</tr>
<tr>
<td>F81 Ethanol pressure lost fault</td>
<td>The ethanol pressure transducer is detecting lower pressure than anticipated</td>
<td>Purge valve C3 was left open, hose or tubing downstream of the ethanol pump are disassembled, faulty pressure transducer, bad pressure transducer wiring</td>
<td>1. Verify purge valve C3 is closed. 2. Verify all hose and tubing connections are assembled and tight.3. confirm pressure transducer wiring is connected and in good condition. 4. Check pressure transducer condition. 5. Call Apeks</td>
</tr>
<tr>
<td>F82 Ethanol flow meter fault</td>
<td>Ethanol flow meter feedback is abnormal</td>
<td>Bad wiring connection to ethanol flow meter, loss of ethanol flow meter power, defective ethanol flow meter, defective analog input card in point IO module</td>
<td>1. Verify wiring connections to flow meter. 2. Verify power on flow meter display. 3. Check connections and wiring condition between flow meter and analog input card in co-solvent remote-control panel. 4. Call Apeks</td>
</tr>
<tr>
<td>Fault Code</td>
<td>Description</td>
<td>Cause</td>
<td>Recommended Action</td>
</tr>
<tr>
<td>------------</td>
<td>-------------</td>
<td>-------</td>
<td>--------------------</td>
</tr>
<tr>
<td>F83</td>
<td>Ethanol level sensor fault</td>
<td>Ethanol level sensor feedback is abnormal</td>
<td>1. Verify wiring connections to level sensor. 2. Verify 24V DC power on level sensor. 3. Check connections and wiring condition between level sensor and analog input card in co-solvent remote-control panel. 4. Call Apeks</td>
</tr>
<tr>
<td>F84</td>
<td>CO₂ flow meter fault</td>
<td>CO₂ flow meter feedback is abnormal</td>
<td>1. Verify wiring connections to flow meter. 2. Verify power on flow meter display. 3. Check connections and wiring condition between flow meter and analog input card in co-solvent remote-control panel. 4. Call Apeks</td>
</tr>
</tbody>
</table>
## Other Symptoms

### 2000 psi Pump

<table>
<thead>
<tr>
<th>Problem</th>
<th>Probable Cause</th>
<th>Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Motor/Pump Does Not Operate:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No power.</td>
<td>Supply correct power according to motor requirements.</td>
<td></td>
</tr>
<tr>
<td>Blown fuse/tripped circuit breaker.</td>
<td>Replace/reset, eliminate circuit overload.</td>
<td></td>
</tr>
<tr>
<td>Shaft coupling to pump not in place.</td>
<td>Install proper coupling hardware (see parts list).</td>
<td></td>
</tr>
<tr>
<td>Current overload - motor.</td>
<td>Motor not rated for pump operating conditions - install proper motor.</td>
<td></td>
</tr>
<tr>
<td>Thermal overload - motor.</td>
<td>Motor not rated for pump and/or ambient operating conditions - supply cooling or install proper motor.</td>
<td></td>
</tr>
<tr>
<td>Faulty motor drive/controller.</td>
<td>Repair/replace.</td>
<td></td>
</tr>
<tr>
<td>Faulty motor.</td>
<td>Repair/replace.</td>
<td></td>
</tr>
<tr>
<td>Low liquid level in supply tank (if low-level shut-off is used).</td>
<td>Fill tank.</td>
<td></td>
</tr>
<tr>
<td><strong>No Delivery</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Supply tank empty.</td>
<td>Fill tank.</td>
<td></td>
</tr>
<tr>
<td>Loss of prime</td>
<td>Re-prime using Initial Start-Up Procedure.</td>
<td></td>
</tr>
<tr>
<td>Inlet line or strainer clogged.</td>
<td>Clear debris and flush, or replace.</td>
<td></td>
</tr>
<tr>
<td>Inadequate supply pressure at pump inlet.</td>
<td>Increase supply pressure by raising fluid level in tank, raising tank, or pressurizing suction tank.</td>
<td></td>
</tr>
<tr>
<td>Inlet line too restrictive.</td>
<td>Increase inlet line diameter and/or decrease inlet line length.</td>
<td></td>
</tr>
<tr>
<td>Fluid viscosity too high.</td>
<td>Reduce viscosity if possible (by heat or some other means). Increase inlet line diameter and/or decrease inlet line length. Increase supply pressure.</td>
<td></td>
</tr>
<tr>
<td>Vapor lock/cavitation.</td>
<td>Increase inlet pressure. Decrease fluid temperature.</td>
<td></td>
</tr>
<tr>
<td>Pump valves held open or worn out.</td>
<td>Clear debris and flush, or replace (see Fluid End Service)</td>
<td></td>
</tr>
<tr>
<td>System relief valve actuating.</td>
<td>Adjust relief valve, or repair, clean, or replace with new relief valve.</td>
<td></td>
</tr>
<tr>
<td><strong>Delivery Too Low and/or Erratic</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Review all Probable Causes and Solutions in Problem 2 No Delivery above.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Air leak(s) in inlet line.</td>
<td>Locate all leaks and repair.</td>
<td></td>
</tr>
<tr>
<td>System back pressure too low.</td>
<td>Adjust back pressure valve to higher setting. Install back pressure valve if none in system.</td>
<td></td>
</tr>
<tr>
<td>Pumped fluid characteristics changed.</td>
<td>Monitor supply tank temperature to determine if fluid is too hot (leading to cavitation) or too cold (increasing fluid viscosity). Stabilize temperature at suitable level to resolve problem. Check for entrapment air in the fluid supply system.</td>
<td></td>
</tr>
<tr>
<td>Inlet supply pressure changed.</td>
<td>Monitor inlet supply pressure (at the pump) to determine if it is too low, causing a starved condition/cavitation. Stabilize pressure at suitable level to resolve problem.</td>
<td></td>
</tr>
<tr>
<td>Pump CK - Calibration system or flow meter error.</td>
<td>Evaluate components and repair/correct problem(s).</td>
<td></td>
</tr>
<tr>
<td>Oil condition in pump hydraulic end changed.</td>
<td>Check oil level - if low evaluate for source of leakage. Consult factory for hydraulic end service.</td>
<td></td>
</tr>
<tr>
<td>Change oil per recommended guidelines in maintenance section.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Delivery Too High and/or Erratic.</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>System back pressure too low.</td>
<td>Adjust back pressure valve to higher setting. Install back pressure valve if none in system.</td>
<td></td>
</tr>
<tr>
<td>Inlet supply pressure changed.</td>
<td>Monitor inlet supply pressure (at the pump) to determine if it is too high, causing a &quot;flow-through&quot; condition. Stabilize pressure at suitable level to resolve problem.</td>
<td></td>
</tr>
<tr>
<td>Pump CK - Calibration system or flow meter error.</td>
<td>Evaluate components and repair/correct problem(s).</td>
<td></td>
</tr>
<tr>
<td>Fault</td>
<td>Possible cause</td>
<td>Symptoms</td>
</tr>
<tr>
<td>-------</td>
<td>---------------</td>
<td>----------</td>
</tr>
<tr>
<td>Pump does not deliver drive motor does not run check</td>
<td>interruption in supply current</td>
<td>no power at motor</td>
</tr>
<tr>
<td></td>
<td>motor or gear defective</td>
<td>drive motor does not run even when separated from pump</td>
</tr>
<tr>
<td></td>
<td>pump is blocked by closed shut-off valve in discharge line</td>
<td>pump can be turned via motor fan wheel at zero stroke, but locks at increased stroke</td>
</tr>
<tr>
<td></td>
<td>pump drive element has seized due to running dry</td>
<td></td>
</tr>
<tr>
<td>Pump does not deliver, pump does not stroke although motor is running</td>
<td>broken components in pump drive element, built-in worm gear defective</td>
<td>disconnected drive motor runs normal</td>
</tr>
<tr>
<td></td>
<td>broken components in gear, coupling defective</td>
<td></td>
</tr>
<tr>
<td>increased running noise</td>
<td>cavitation or overmetering taking place.</td>
<td>noise only occurs at increased stroke lengths or speeds</td>
</tr>
<tr>
<td></td>
<td>gear is defective</td>
<td>flowrate unsufficient, mostly accompanied by unregular operating noise</td>
</tr>
<tr>
<td></td>
<td>axial play of worm shaft has increased</td>
<td></td>
</tr>
<tr>
<td></td>
<td>shaft connections or coupling components worn out due to overloading</td>
<td></td>
</tr>
<tr>
<td></td>
<td>pump drive components damaged due to overload</td>
<td></td>
</tr>
<tr>
<td></td>
<td>bearing damage</td>
<td></td>
</tr>
</tbody>
</table>
8. References

- Visit and subscribe to our YouTube channel for instructional videos: https://www.youtube.com/user/ApeksSupercritical.
- Visit the Apeks online store for parts related to your system: https://www.apekssupercritical.com/shop/.
- For more information regarding software updates and to sign up for e-mail alerts, visit: https://www.apekssupercritical.com/service-request/.
9. Appendices

Appendix A – Torque Requirements

1. Fuse Holders (1492-H6) = 7.1 lb-in
2. Fuse Holders (3046401) = 15.93 lb-in
3. Power Supply (1606-XLE120E) = 7 lb-in
4. Terminal Blocks (1492-J4) = 9 lb-in
5. Terminal Blocks (3044102) = 7.08 lb-in
6. Ground Blocks (1492-JG4) = 9 lb-in
7. Ground Blocks (3044128) = 7.08 lb-in
8. Ground Block Middle Screw (1492-JG4) = 7.1 lb-in
9. JG10 Large Ground Blocks (1492-JG10) = 20.4 lb-in
10. JG10 Large Ground Blocks (3044173) = 15.93 lb-in
11. JG10 Large Ground Block Middle Screw (1492-JG10) = 8.9 lb-in
12. Small Motor Contactor Phillip Screws (100-C55D10) = 31 lb-in
13. Small Motor Contactor (43-44) Phillip Screws = 13 lb-in
14. Overload Relay (T1/T2/T3) Phillip Screws = 22 lb-in
15. Overload Relay (95-98) Phillip Screws = 5 lb-in
16. Large Motor Contactor Allen Screws (100-C72D10) = 53 lb-in
17. Large Motor Contactor Phillips Screws (100-C72D10) = 13 lb-in
18. Overload Relay Allen Screws (193-EEGE) = 35 lb-in
19. Overload Relay Phillips Screws (193-EEGE) = 5 lb-in
20. Micro 850 Power Supply = 4.4 lb-in
21. Micro 850 Terminal Strip = 4.4 lb-in
22. 2080 TC2 = 2.21 lb-in
23. 2080 IF4 = 2.21 lb-in
24. 2080 IF2 = 2.21 lb-in
25. HMI (2711R-T10T) = 5 lb-in
26. Yellow Terminal Jumpers = 7.1 lb-in
27. Estop Contact (800F-X01) = 8 lb-in
28. Relay Base Screws (700-HN123) = 7 lb-in
29. 2080 IF8 = 5.3 lb-in
30. Relay Output Module (2085-0W8) = 5.3 lb-in
31. 7A Circuit Breaker (18 AWG) = 13.3 lb-in
32. 7A Circuit Breaker (14 AWG) = 17.7 lb-in
33. 7A Circuit Breaker (8 AWG) = 39.9 lb-in
34. Ewon Flexy Power Connector = 7 lb-in
35. Ewon Cosy Power Connector = 7 lb-in
36. 125V Plug = 12 lb-in
37. Lightly Managed Ethernet Switch (Stratix 1783-LM58) GND + Ring Terminal Lugs = 4.5 lb-in
38. Lightly Managed Ethernet Switch (Stratix 1783-LM58) Power Connector = 1.7 lb-in
39. Power Supply (1606-XLE240E) = 7 lb-in
40. Compact Logix I/O Module Terminal Block (5069-RTB18) Screw = 3.5 lb-in
41. Panelview HMI (2715-T12WD) = 4.4 lb-in
42. Small Motor Contactor = 31 lb-in
43. Small Motor Contactor Phillips Screw = 13 lb-in
Questions?

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