

4. Operating Procedures

When starting the system for the first time it is necessary to follow the procedures described in this section. It has been assumed that the system has been installed correctly and all lines are connected. Before filling the system with liquid nitrogen it is advisable to roughly pump out all parts of the cryo-cooler (pipework and vessel) through the high pressure fill valve, V3 and the low pressure fill valve, V4 and back fill with nitrogen gas. Figure 3.1-2 shows a schematic flow diagram for the cryo-cooler.

4.1 Switching on the Control Rack

4.1.1 Connecting the control rack.

Connect one end of the 50w D connector cable to the signals box mounted on the cryocooler vessel. Connect the other end to SK4 on the rear panel of the rack control unit inside the control rack.

Connect one end of the Harting power cable to the mains box mounted on the cryocooler

Connect the other end to SK1 on the connector panel at the rear of the control rack.

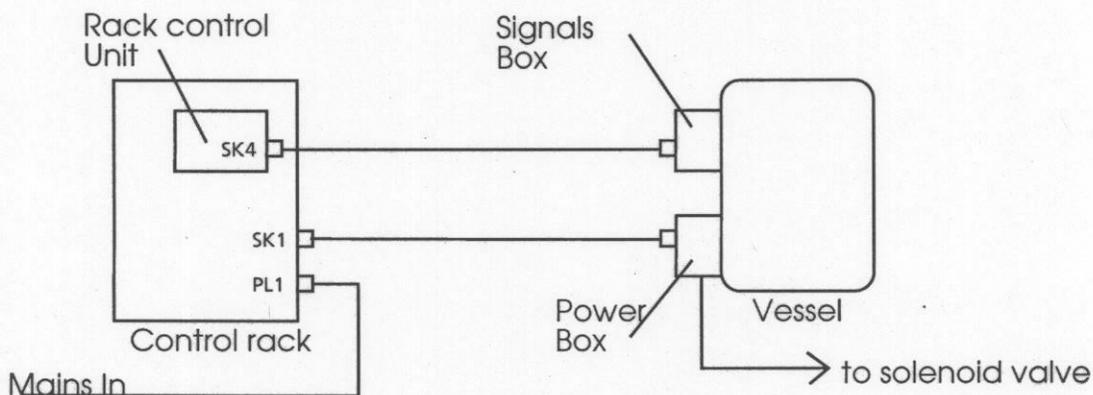


Figure 4.1-1 Cryocooler connection Diagram

4.1.2 Powering the control rack

Plug in the mains supply to PL1 on the rear connector panel of the control rack

Turn on the breakers on the distribution panel at the rear of the rack

The **MAINS ON** lamp on the control unit front panel should be lit

Press the **ON** button on the control unit front panel

The **RACK ACTIVE** lamp should light, and the control units should power up.

To turn the control rack off to standby press the **OFF** button on the control rack front panel.

The **RACK ACTIVE** lamp should turn off, but the **MAINS ON** lamp should still be lit

To isolate the system completely - pull out the mains connector from PL1 on the rack.

4.2 Initial Cooldown and Fill

CAUTION: Whenever the isolation valves V1 and V2 to the optic are closed, always ensure that the manual vent valve V5 is open.

CAUTION: Whenever the isolation valves V1 and V2 are closed, always ensure that the by-pass valve V10 is open.

To cool down the system for the first time, follow the steps given below.

1. Pump out the high pressure circuit by closing all the valves and connecting a roughing pump to the liquid nitrogen fill line, (i.e. the junction of valves V3 and V4). Open valves V1, V2 and V3 and evacuating to about 10^{-2} mbar. Close V3 and remove the roughing pump from the system.
2. Turn on the rack power and check that the control units power up. Set the control pressure to 0 psi (atmospheric pressure). Check the set points for the level meters, (50% for the vessel and 75% for the high pressure reservoir).
3. Connect the liquid nitrogen fill line from the supply to the junction of valves V3 and V4. Open V3 just long enough for the pressure to rise to about 2 or 3 psi above atmosphere. Open V4 to start the liquid flowing into the vessel. This will cool the vessel with the gas exhausting through the vent line. It is advisable to attach a line to the vent to control where the exhaust gas is discharged.
4. Monitor the vessel level and close V4 when the level rises to between 45% and 50%. This will ensure that the fill solenoid valve remains open. Once the level is allowed to reach 55% the solenoid valve will close and remain so until the level is reduced to 45%.

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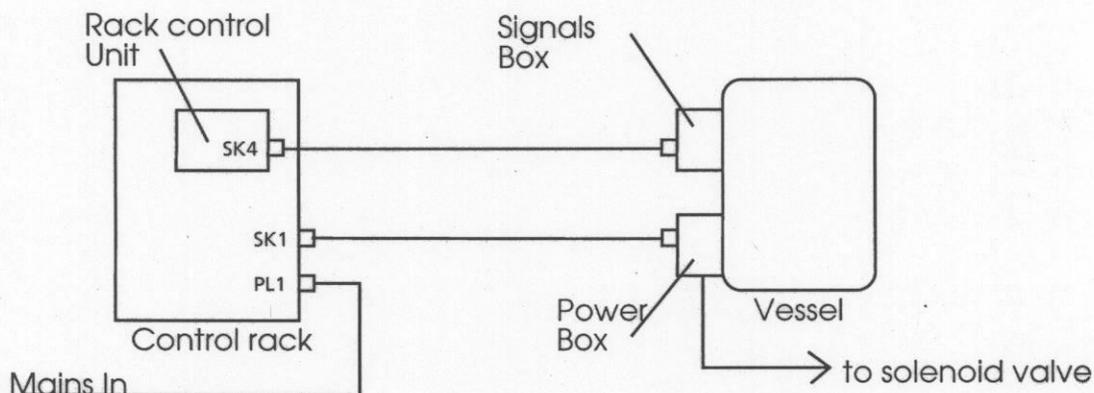


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4. Monitor the vessel level and close V4 when the level rises to between 45% and 50%. This will ensure that the fill solenoid valve remains open. Once the level is allowed to reach 55% the solenoid valve will close and remain so until the level is reduced to 45%.

5. Open V5, V6, V10 and V12, close V2. V3 can then be opened to start filling the high pressure circuit. This can be started during the vessel fill. As soon as spots of liquid are seen emerging via V12 or V5 the associated valve should be closed. Monitor the high pressure level and close the fill valve V3 when the level reaches 80%.

4.3 Initial Start-Up

CAUTION: Whenever the isolation valves V1 and V2 to the optic are closed, always ensure that the manual vent valve V5 is open.

CAUTION: Whenever the isolation valves V1 and V2 are closed, always ensure that the by-pass valve V10 is open.

1. Start the circulating pump at a frequency of 20 Hz.
2. Open V5 slightly to let out any gas and close as soon as spots of liquid appear. If the level falls too low the open the fill valve V3 to get the level back to 80%.
3. Open V2 and close V10 to send the full flow through the load. Continue to vent gas, as necessary through V5, filling as required to keep the level in the high pressure reservoir between 60% and 80%.
4. Once the high pressure circuit is stable with no trapped gas, close V6. Monitor the pressure in the high pressure circuit and relieve it, by briefly opening V6, if the pressure rises above 40 psi. Large level changes with pressure change indicate the presence of trapped gas and further venting via V5 will be necessary.
5. Once the high pressure circuit and the load have cooled down the pressure will drop to below 20 psi. Open V4, the vessel fill valve, and leave open so that the vessel is re-filled automatically each time the level drops to 45%.

4.4 Raising the Closed Loop Pressure

With the system filled and the pump running, the pressure in the closed loop can then be raised to the operating pressure. The following steps describe how to change the pressure setpoint. More detailed information is given in the operators instructions on the Dwyer 1600 series controllers.

1. Press the INDEX button I on the pump inlet pressure controller until SP1 is seen in the lower half of the display.

2. Set the required pressure setpoint (minimum value 35 psi at 2.5 kW, maximum value 75 psi), shown in the upper half of the display, by increasing or decreasing the value using the UP-ARROW or DOWN-ARROW buttons.
3. When the required pressure setpoint is reached, press the ENTER button E.
4. Press the INDEX button I twice to return to monitoring mode.
5. If the setpoint is raised, the heater power in the high pressure reservoir will be increased, to boil off gas to raise the system pressure. The controller will then control the heater power to maintain the pressure at its setpoint.

4.5 Operational Mode

After following the steps above, the cryo-cooler will be fully operational. Ensure that there is adequate liquid supply to the vessel top-up line to replace liquid boiled away. The vessel will fill automatically from the liquid nitrogen top up dewar, as a solenoid valve on the top of the dewar will open when the nitrogen level in the vessel falls below the setpoint (50%). Even with no optic heat load there is residual heat input to the system which will boil away the liquid in the vessel. The cryocooler is likely to consume up to 1600 litres per day with the cryocooler operating at full power.

If the liquid supply to the vessel is stopped, the vessel will drain and the heat taken up by the circulating liquid cannot be dissipated. This will raise the closed loop system pressure until relief valves open.

Caution: Always ensure there is an adequate supply of liquid nitrogen to the vessel to cover the operating time planned. Approximately 600l is required for 8 hours operation at 2.5kW

Note 1: It is not advisable to run the motor if there is no liquid level shown on the high pressure reservoir meter. Running the motor without liquid present may result in damage to the pump.

Note 2: The level probe in the high pressure buffer is captive. The black nut must be unscrewed completely to remove the high pressure buffer level sensor.

4.6 Lowering the Closed Loop Pressure

To lower the pressure in the system:

1. Change the setpoint on the controller to 15 psi absolute pressure.
2. Gradually open valve V6 whilst monitoring the pressure.
3. When the system has reached 15psi, close valve V6

4.7 Warming up the Optic

1. Follow the procedure given in section 4.6 for lowering the system pressure to atmospheric pressure.
2. Open bypass valve, V10.
3. Open vent valve V5.

Caution: Never leave valves V1 and V2 closed at the same time that valve V5 is closed.

4. Close valves V1 and V2, to isolate the optic from the cryocooler high pressure circuit.
5. Remove the transfer line from V1.
6. Connect a supply of warm nitrogen gas to V5.
7. Circulate warm nitrogen gas through the optic, to warm it up.