Helium Liquefier/Refrigerator

Below is a description of the System Components

Cold Box

The helium liquefier / refrigerator cold box is a Cryogenic Consultants, Inc. CCI Model 300 JPS with the optional wet engine module. The cold box was manufactured by Meyer Tool& Manufacturing Incorporated, Oak Lawn, Illinois. The cold box is designed to produce 400 watts refrigeration at 4.5 K or 100 liters of liquid helium per hour from warm helium gas. Liquid nitrogen is supplied to the cold box as a pre-coolant. Liquid nitrogen consumption is rated at 0.7 liters of liquid nitrogen per liter of liquid helium produced.

Photo 1 - CCI Cold Box

The ‘cold box' is a super insulated, vacuum jacketed component containing the heat exchangers, extended stem cryogenic valves, expansion (JT) valve and a piston type expansion engine. Helium gas, compressed to265 PSIG, enters the cold box at near room temperature and is cooled with liquid nitrogen and low pressure helium gas. The high pressure helium is further cooled by the cold helium gas exiting the piston expansion engine. This low press cold gas is produced when a portion of the high pressure gas stream expands in the cylinder of the "piston type" expansion engine. The remaining high pressure helium gas travels to a JT expansion valve or a wet expansion engine where the temperature of the gas is reduced to the liquefaction temperature of helium. The liquefied helium exiting the JT valve or wet expansion engine is transferred to the liquid helium dewar through bayoneted vacuum jacketed transfer tubes. A small portion of the helium returns as cold helium gas to the cold box to be used to cool the high pressure helium gas stream.

Photo 1 shows the cold box as manufactured. Modifications to the instrument panel on the cold box can be seen in Photo 2. The changes include moving the gas expander speed control box to a location above the control panel. An electrical enclosure was installed in place of the speed control box to house three PID controllers.

Photo 2 - Modified Control Panel

Controls

The system is controlled with pneumatic actuators and controllers. However the helium suction pressure incorporates a duel output PID controller and two I/P transducer controlled pneumatic actuated valves to supply helium make up gas or remove excess helium in the suction manifold. A common problem associated with pneumatic controls is the internal corrosion created by moisture carried in with the instrument air. Rather than using compressed air, this system has been operated from the boil off nitrogen gas created in the liquid nitrogen storage tank. As a result, the controllers and actuators are clean and corrosion free.

Helium Gas Management Rack

The helium gas management rack consists of three pneumatically controlled valves used to maintain compressor discharge and suction pressures. The valves are compressor discharge or "by-pass valve", suction make up and suction withdraw valves.

Photo 3 - Gas Management Rack

Compressor

Photo 4 - Sullair Compressor

The helium compressor is an oil flooded screw compressor Sullair Model C20LA 704-48-400 HP. The compressor is driven by a 480 Volt AC electric motor with a rating of 400 horse power. The screw compressor has a built in slide-valve to match compressor capacity with refrigeration load thus permit efficient system operation.

In photo 4, the electric motor is the gray unit located on the right side of the vertical oil knock out tank.

Photo 5 - Recovery Compressor

Recovery compressor

A 25 HP Dunham Bush Compressor, seen in Photo 5, stores the helium boil-off cryostats when the Sullair compressor is off. The small compressor can be used to circulate ambient temperature helium to warm cryogenic devices.
A 25 HP Dunham Bush Compressor, seen in Photo 5, sends helium boil-off gas to the storage vessels when the Sullair compressor is off. The small compressor can be used to circulate ambient temperature helium to warm cryogenic devices.

Compressor Oil Purifier

The DuPont LB 170X oil is processed before installation into the Sullair compressor.

The process, seen in Photo 6, heats the compressor oil in the two vertical tanks while under vacuum to remove moisture or chemicals that may separate from the oil during compressor operation. The oil in the two tanks can be pressured and sent directly into the oil knock out tank as needed.

Photo 6 - Compressor Oil Purifier

Cooling Tower

The Sullair and Dunham Bush Compressors are water cooled by a 125 Ton Delta Cooling Tower. The water is circulated by a 300 gallon per minute centrifugal pump through a PVC piping system. The tower shell is made of seamless polyethylene (LDPE). The wet decking and drift eliminator are constructed from a spiral, one piece ABS. The blower fan motor is a 15 HP, 460 volt, 60 Hz., 3 phase, ODP type.

In Photo 7, the black Delta Cooling Tower can be seen located in front of the helium gas storage tanks. The squirrel cage type fan can be seen on the left side of the tower body. The venting air flows upward through the tower. The water make up valve for the tower is located in the gray box to the right of the tower body. The makeup water valve provided by the manufacturer of the tower was located inside the tower. Problems associated with this location resulted in the relocation and redesign of the makeup water system.

Photo 7 - Delta Cooling Tower with Helium Vessels in Background

A 3,000 gallon cryogenic tank being sold separately provides pre-cooling to the refrigerator and cooling to the thermal shield in the 1500 liter helium Dewar. The LN2 tank is connected to the cryogenic test area by a vacuum insulated transfer line. The nitrogen gas is used for instrument air and also available for pump down and purge of insulating vacuum spaces.

The liquid nitrogen fill pedestal, seen in Photo 11, is located at the curb side for ease of refilling. Photo 12 shows the liquid nitrogen pedestal located at the liquid nitrogen tank.

Photo 11

Photo12

Photo 13 - Liquid Helium Tank

Liquid Helium Storage

A 1500 liter liquid helium Dewar stores and distributes the liquid helium through two flow control valves equipped with bayoneted ports The valves are a low heat leak design utilizing springs to close and a stainless steel pull rod to open. The liquid helium valves are positioned with a Foxboro / Jordan Model VA-1110 electric actuator. The valve position is determined by a 4-20 ma signal from a temperature controller or liquid level controller.

The liquid helium Dewar contains liquid nitrogen reservoir to provide coolant to a thermal shield.

Other Components

Photo 14 - CVI Vacuum Pump Out

Vacuum jacketed piping

All cryogens are transferred between components through vacuum jacketed, super insulated piping. Each vacuum space is equipped with a DV-6 thermocouple vacuum gauge and a CVI pump out / vacuum relief valve as shown in Photo 14.

Connecting piping and fittings

All high and low pressure helium piping is fabricated from 304 stainless steel pipe or tubing.

Written Safety Plan

Lockout / Tag out Procedure - contains a detailed lockout / tag out procedure including flow drawings. Photo 16 shows isolation valve locked out.