OPERATING
the
HIGH ALTITUDE VACUUM
CHAMBER

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Introduction

The construction details for this high altitude vacuum chamber are provided in a separate document: Construction Manual for High Altitude Test Chamber.

The system as constructed has achieved temperatures of -35 ^{o}C (238 K) and pressures of 40 Pa (equivalent to 55 km altitude) in initial tests at DePauw.

Placing the test object into the chamber

The procedure to use the system starts with placing the test object inside the pipe casing resting on top of one of the Lexan lids. The ends of the casing are coated with a thin layer of silicon vacuum grease. Another thin layer of vacuum grease is applied to the lid. A rubber gasket is placed between the lid and the casing. The support rods pass through the Lexan lid with hex-head nuts on each side of the lid. The cylinder is oriented with its axis vertical and the other lid is placed on the open end of the chamber with similar vacuum grease coatings and a rubber gasket. The second set of hex-head nuts are on each side of the lid on each support rod. A refrigerant hose is connected to the flare fitting on the side of the chamber. The assembled chamber is seen in Figure 1.

Figure 1 - Assembled test chamber

Placing the test chamber into the freezer

Before lifting the test chamber into the freezer, please check that the hex-head nuts are tightened on all three support rods. Carefully lift the chamber and lower it into the freezer cavity. The chamber should rest on the lowest level of the freezer cavity and the vacuum hose should be closer to the top of the freezer. The free end of the vacuum hose is connected to the flare union that passes through the lid of the freezer. See Figure 2.

Figure 2 - Test chamber inside freezer compartment

Pump, Manifold, and Vacuum Gauge connections to freezer

Figure 3 shows the connections between the pump, manifold, vacuum gauge and freezer.

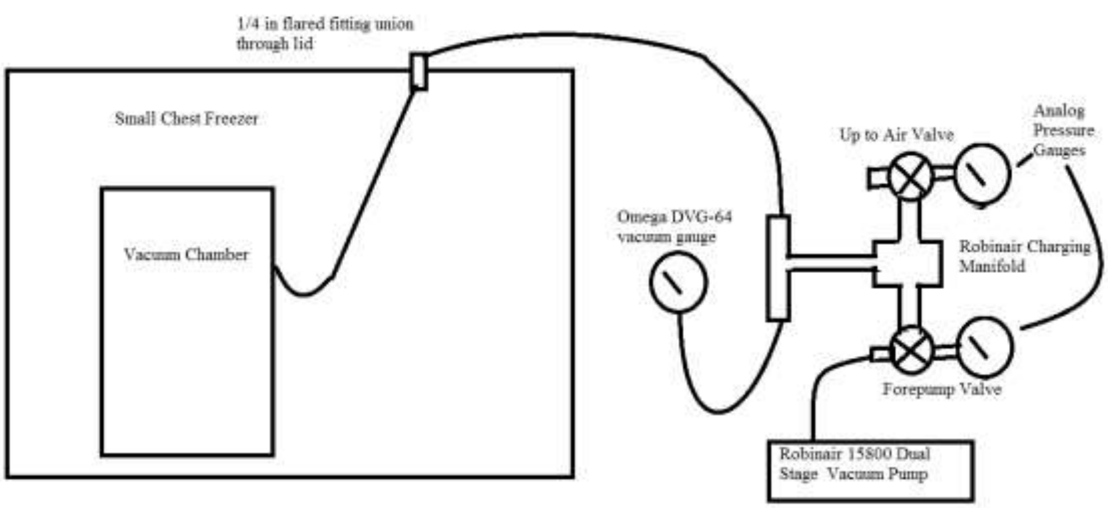

Figure 3 - Schematic of connections between pump, manifold, vacuum gauge and test chamber in freezer

The Robinair vacuum pump is connected to the flare fitting on the side of the manifold with the blue handle valve (the low-pressure end of the manifold) via a refrigerant hose. Nothing is connected to the flare fitting with the red handle valve (the high-pressure end of the manifold). The Omega DVG-64 vacuum gauge is connected by a refrigerant hose to an open flare fitting on the galvanized tee that connects through the pipe nipple to the center hole in the manifold. The remaining side of the tee is connected with a refrigerant hose to the flare union on the outside of the lid of the freezer. Figure 4 shows the pump, Omega vacuum gauge and the manifold connected with refrigerator hoses to the fitting on the freezer lid.

Figure 4 - Pump, Manifold, and Omega Gauge connected on top of freezer

Please note that the Omega DVG64 gauge has two ports, but the hose must be connected to the VAC side of the gauge!

Before starting the pump, check that both valves on the manifold are closed (turned fully clockwise).

Starting the Vacuum Pump

With the valves closed, you may start the Robinair Vacuum Pump. Since the pump is only evacuating the short line to the manifold, the pump should quickly remove the air and pump quietly. The small diameter refrigerant lines slow the pumping speed, but this makes for a slightly better simulation of the ascending balloon experiment. After a few seconds, you can open the blue-handled valve to connect the pump to the chamber and the Omega vacuum gauge. As the valve is opened, the pump will gurgle and you will see oil mist coming from the exhaust port of the pump. The analog gauge on the blue handled side of the manifold should move below zero headed indicating a partial vacuum (red portion of the outer scale - the units are inches of mercury). Again, please note that the pumping speed is very slow. HOWEVER, if the gauge does not drop below zero, then there is a leak in the vacuum line or the test chamber. You will have to check to find the leak and fix it.

As the pump continues to work at removing the air from the large vacuum chamber through the narrow hose, the pressure will continue to drop. When the analog gauge reads about 20 inches of vacuum, you can turn on the Omega digital gauge. Turning on the gauge requires pushing the on button for about three seconds. The gauge will read Powerup Test and then read Atm and Units (either Pascal, Torr, mTorr, Microns, PSIA, In Hg, or mBars). The Units will disappear and be replaced by a set of black squares that should repeatedly decrease from right to left for several cycles, until the pressure reaches the upper reading limit on the gauge. This process may take 10 to 20 minutes! While waiting, you can still see the analog gauge needle move toward a lower vacuum.

Starting the Freezer

After the vacuum pump has been running for at least ten minutes, you may turn on the freezer. It is recommended that you turn the thermostat to its lowest setting. Do not turn the freezer on before beginning the pumping sequence to avoid creating a frost buildup in the freezer.

Running the Trial

The system will continue to operate for as long as you need to run the trial. Trials on the prototype system reached ultimate minimum temperature and pressure after two to three hours of running both the pump and the freezer. The longest experiment runs were about twenty-four hours. The Omega gauge will auto-shutoff, or you can turn it off earlier to conserve the battery life.

Ending the trial

When the trial is completed, turn the freezer off and open the lid to the freezer. Allow the system to return to room temperature before stopping the vacuum system. To stop the vacuum system, turn off the Omega gauge, close the blue-handled valve completely, and open the red-handled valve to allow air to enter the test chamber. When the air has filled the system, the upper lid may be removed from the chamber by removing the upper hex-head nuts.