

MiTeGen

GraVetri 4C Module

User Manual



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Statement of Purpose

This manual is **ONLY** meant to cover safe unpacking, installation, and operation of the GraVitri 4C Module. It is expected that, before reviewing this manual, the user has reviewed and is familiar with the "GraVitri Plunge Cooler Series: User's Manual v1.0", which covers instructions for the safe unpacking, installation, and operation of the plunge cooling element of the system. If you have any questions, or are not confident at any point during the review of either of these manuals, please contact our Support Team at support@mitegen.com or call 1-607-266-8877.

Overview Schematics

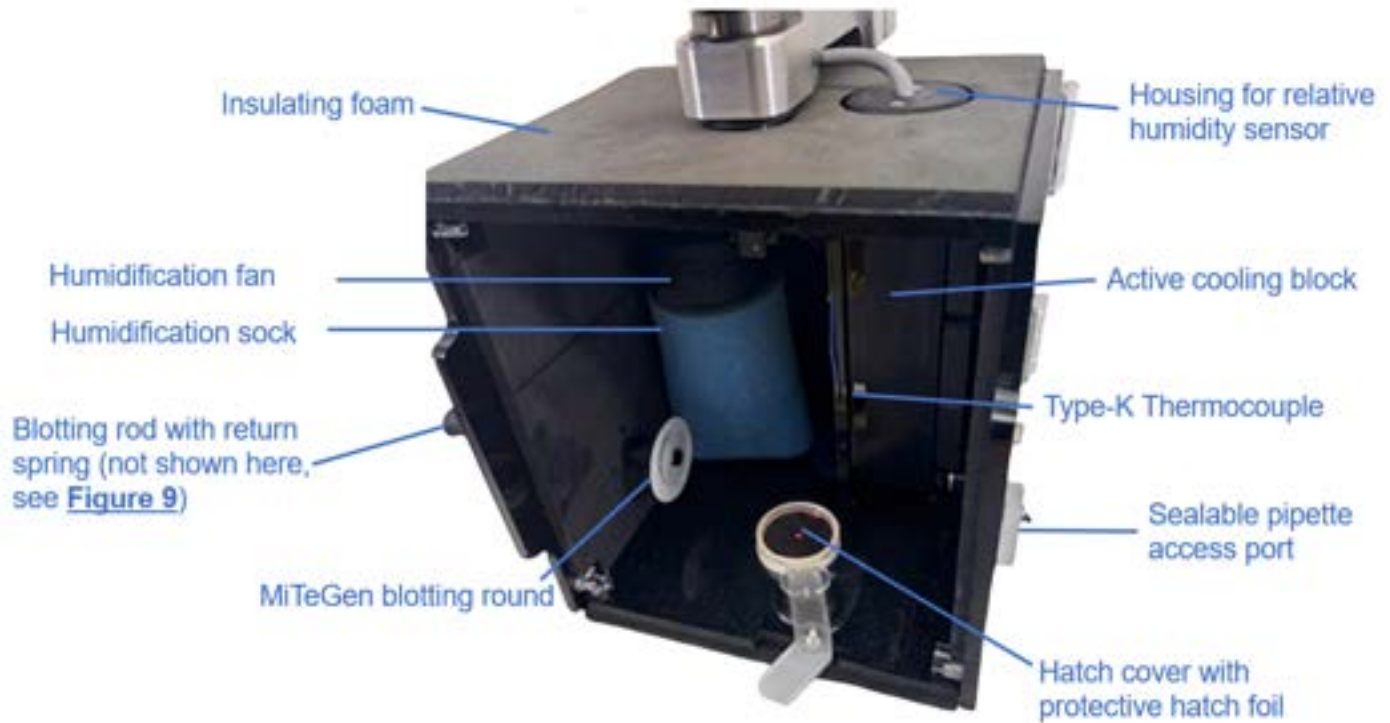


Figure 1: Overview schematics of enclosure for GraVetri 4C Module

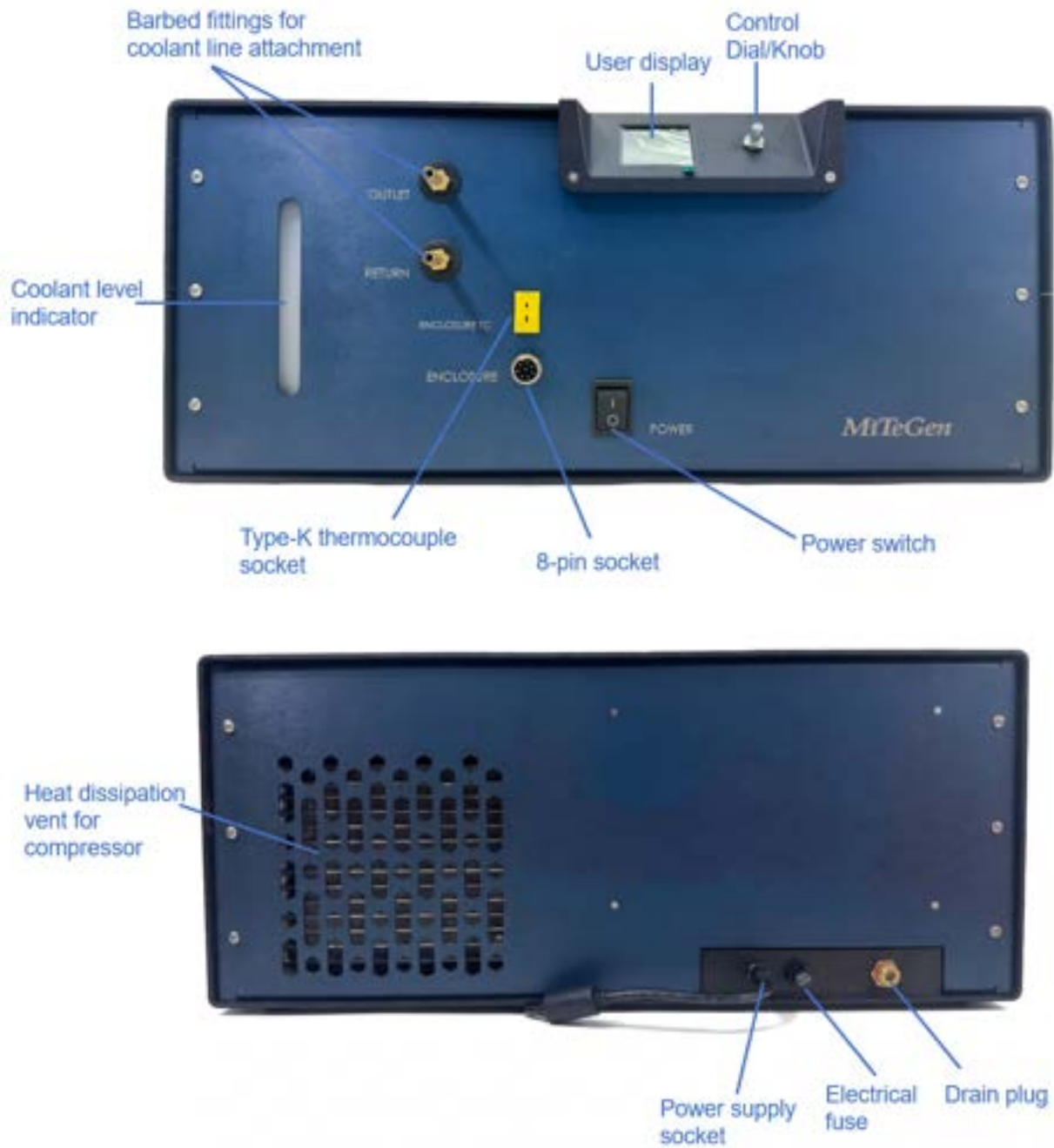


Figure 2: Overview schematics for front panel (top) and back panel (bottom) of chiller unit for GraVetri 4C Module

Handling and Operational Precautions

Notice: It is expected that, before reviewing this manual, the user has reviewed and is familiar with the “GraVitri Plunge Cooler Series: User’s Manual v1.0”, which covers instructions for the safe unpacking, installation, and operation of the plunge cooling element of the system. **If you have not done so yet, review this document before proceeding further.**

Caution: All users must read this manual, become aware of the hazards, and be properly trained before use.

Notice: This manual covers the specific usage of the GraVitri 4C Module. The equipment is designed to only be used in facilities and labs where there are policies and procedures regarding the safe use and disposal of liquid nitrogen and flammable cryogenics, and where the facility has provided to the personnel the training necessary for such safe usage and disposal. The laboratory or facility is responsible for providing a proper working environment and acceptable safety equipment.

Caution - chemical toxicity: The system uses 20% ethylene glycol and water mixture as the coolant. **DO NOT USE PURE WATER OR OTHER ADDITIVES WITH THE UNIT.** Ethylene glycol is toxic if ingested! When purchasing and using ethylene glycol, please ensure that you have reviewed any relevant safety information, including but not limited to appropriate Material Safety Data Sheets.

Warning - IT IS THE RESPONSIBILITY OF THE USER TO INSTALL THE UNIT PROPERLY.

- Forcing connectors and fittings will result in damage that will require shipping the unit back to MiTeGen for repair.
- Not properly installing hoses and fittings will result in coolant leakage.

Warning - system handling and use: The chiller unit contains a refrigeration compressor for the cooling system. Do not power up the unit for at least 12 hours after moving or shipping the chiller unit

Warning - system handling and use: When plugging sensors into the chiller unit and providing it with power, be cognizant of locating features and the shape of the male and female features on the connectors and sockets. Insertion of connectors requires minimal force. **FAILURE TO PROPERLY ALIGN CONNECTORS WITH COMPLEMENTARY SOCKET FEATURES FOLLOWED BY FORCING THE CONNECTOR INTO PLACE WILL RESULT IN UNCOVERED DAMAGE TO THE CONNECTORS AND/OR SOCKETS.**

Warning - Electrical Specifications and Safety - The chiller unit houses a number of electrical and electromechanical components. It runs on 24V power. The unit is protected by a 5A slow blow fuse. The unit remains open to the environment to allow for efficient heat dissipation. **Make sure that the chiller unit, especially the rear openings in the exterior housing, remains dry and clear of obstructions. Failure to ensure this could result in damage to and failure of the system.**

Installation

- STEP 1.** Review the “GraVitri Plunge Cooler Series: User’s Manual v1.0” and ensure that all installation steps, up to **but NOT** including installation of the passive enclosure, have been completed.
- STEP 2.** With the included 2.5 mm hex key, mount the enclosure for this module to the stem using the three M4 screws and washers. (See **Figure 3** below). Use the locating features on the enclosure’s exterior foam to aid with alignment of the enclosure, and position the unit such that the screw direction is perpendicular to your line of sight. Place the washer onto

the screw and insert through the inside of the enclosure to mount the enclosure to the stem.



Figure 3: Assembly of Gravitri 4C enclosure and stem by three M4 screws

STEP 3. Unscrew the small thumb screw from the tweezer mount. Press and hold down the foot pedal (or squeeze the handbrake-style release) to draw back the rod release mechanism, then gently slide the rod down through the bearings until the release plate aligns with one of the grooves in the rod (see **Figure 4**, terminology used here defined in “GraVitri Plunge Cooler Series: User’s Manual v1.0”). Release the foot pedal (or handbrake-style release) and the rod will be retained in place. Re-insert the previously removed thumb screw once the rod is in place.

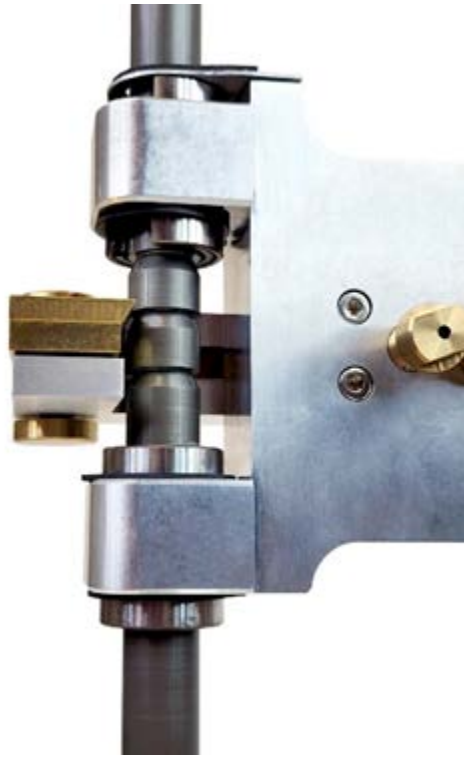


Figure 4: Release plate aligned with groove in drop rod

- STEP 4.** Connect the coolant lines from the enclosure to the front panel of the chiller unit by connecting to the appropriate barbed fittings (see **Figure 5** below). Lightly tug on connected lines to ensure secure connection; if properly connected, the tube should not be able to be removed from the fittings when lightly tugged. **Note:** there is no inherent directionality to coolant flow. It does not matter which tube gets connected to which fitting, so long as both are properly connected.



Figure 5: Coolant line connection to front panel of chiller unit

STEP 5. Insert thermocouple connector coming from the enclosure into the corresponding socket on the chiller unit (see **Figure 6** below). **Note:** the chiller unit expects a Type-K thermocouple. A separate, user provided Type-K thermocouple can be substituted in if desired.



Figure 6: Connection of Type-K thermocouple to chiller unit

- STEP 6.** Align the locating feature on the 8-pin connector from the enclosure to the complementary feature on the socket located on the front panel of the chiller unit (see **Figure 7** below). Once aligned, gently insert the connector into the socket. **Failure to properly align connector and socket followed by the application of excessive force will result in uncovered damage to the unit. DO NOT DO THIS!**



Figure 7: 8-pin connector from enclosure (left) and complementary socket on front panel of chiller unit (right). **TAKE NOTE OF THE SEMICIRCULAR LOCATING FEATURES AND ALIGN THEM BEFORE APPLYING FORCE AND SCREWING THE THREADED FASTENER**

- STEP 7.** **Warning- safety glasses are required for this step:** Prepare 2 liters of 20% ethylene glycol coolant by mixing 400 mL of ethylene glycol with 1600 mL of water. **Be sure to follow any and all safety precautions and instructions provided by the ethylene glycol vendor when handling the chemical.**
- STEP 8.** **Warning- safety glasses are required for this step:** Remove the fill cap on the chiller unit. Using the provided funnel, fill the reservoir with 2 liters of the prepared coolant, then replace the cap (see **Figure 8** below). The coolant level should be about 3/4" - 1" below the top of the viewing window at the front panel of the unit.

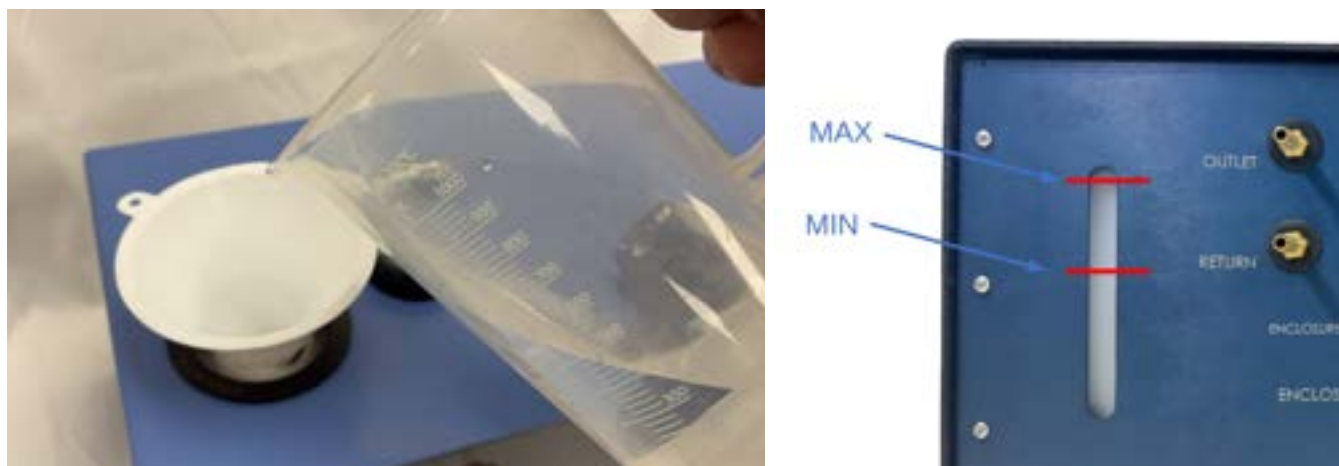


Figure 8: Appropriate set up for filling of chiller unit with coolant (left) appropriate coolant level as visible from the front panel of the chiller unit (right)

STEP 9. Plug in the power supply in the back of the unit

Operation

Warning: Safety glasses required for operation of the plunger

STEP 1. With enclosure doors open, slide the return spring onto the blotting rod. Then, without cap, slide the blotting rod through the appropriate port on the enclosure side door (please refer to **Figure 2**) with the rod's female end sticking into the enclosure. Open the door and slide the blotting round supports, blotting round, and cap onto the end of the blotting rod (see **Figure 9** below). Close the door.



Figure 9: Correct assembly of blotting round and blotting rod through the enclosure side door

STEP 2. If humidifying the enclosure, soak the humidity sock in water. Wring the sock until water just stops dripping from the sock. When finished, mount the sock on the humidification fan (see **Figure 10** below)

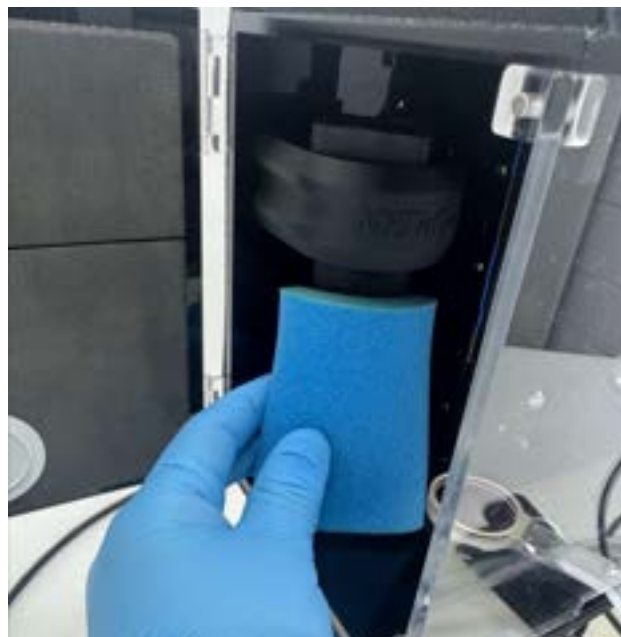


Figure 10: Mounting of humidification sock on humidification fan

STEP 3. Ensure that the plunge hatch is covered with a hatch foil (see **Figure 11** below). If a hatch foil is not yet present in the enclosure, please be sure to install one. Close both enclosure doors.

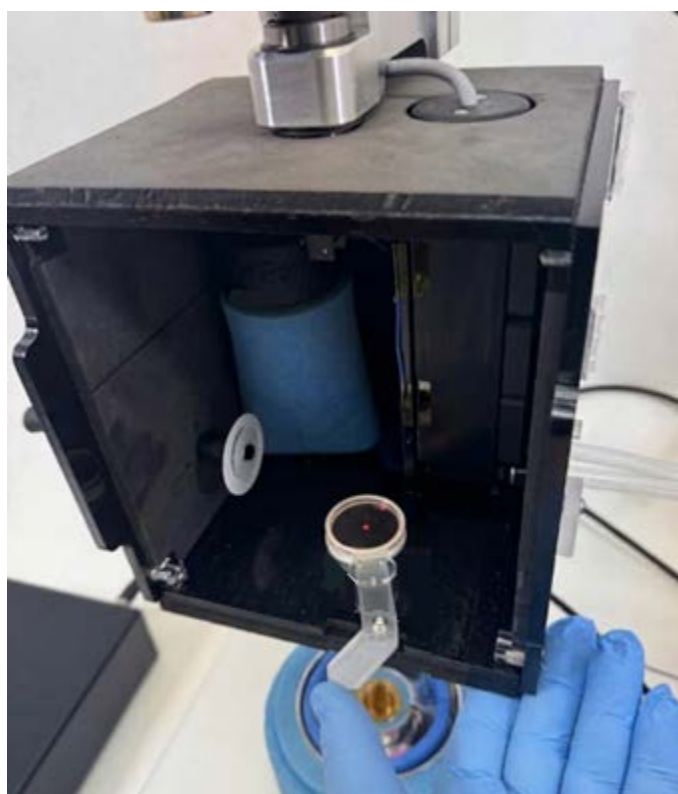


Figure 11: Sealing of plunge hatch prior to cooling and humidification of enclosure

STEP 4. Turn the power switch on the front panel of the chiller unit “On”. This should turn on the user display which provides readings on the temperature and humidity inside the enclosure, the current coolant temperature, the current temperature setpoint value, and the current humidifier status (on/off) (see **Figure 12** below). Turn the dial next to the display to adjust the temperature setpoint. Push the knob in to toggle the humidifier on and off. When the enclosure reaches the set temperature, the external unit will sound 3 short beeps.



Figure 12: Front panel user display for chilling unit directly after powering on

- STEP 5.** Wait for the enclosure to reach target temperature and humidity. This process should take <45 minutes (see **Figure A2** for a typical enclosure cooling profile). While waiting, prepare the liquid ethane and load grid boxes into the grid box holders, as many as are needed to store the number of grids to be plunged. **Note:** When loading grids into grid boxes, only one hand will be free to perform manual tasks. Thus, prior to plunge, prepare a grid box to receive the next plunged grid without additional manual intervention. **Note:** If using the MiTeGen Cryostat and Temperature Controller, please refer to the user manual for these products. **Note:** While these operation instructions refer explicitly to liquid ethane, they are equally applicable to all commonly used hydrocarbon-based cryogens (e.g. liquid propane, liquid ethane-propane mixture, etc.)
- STEP 6.** Once the ethane has been prepared and the enclosure environment has reached its setpoint, proceed with grid loading. Instructions for this are outlined in **STEPS 3.5-5** of the “GraVitri Plunge Cooler Series: User’s Manual v1.0”. Perform these steps quickly and immediately close enclosure doors once complete to minimize heat leakage into the enclosure.

- STEP 7.** Proceed with sample application, blotting, plunge cooling, and loading of plunged grids into grid boxes. Instructions for this are outlined in **STEPS 8-16** of the “GraVetri Plunge Cooler Series: User’s Manual v1.0’.
- STEP 8.** When finished preparing grids, switch the power switch on the front panel of the chiller unit to “Off”. Remove the humidity sock from the enclosure and leave at least one of the enclosure doors open to let the enclosure dry out when not in use (see **Figure 13** below). Once dry, place humidity sock inside enclosure and close enclosure to ensure all components stay together and dust and debris do not accumulate inside the enclosure or the sock.

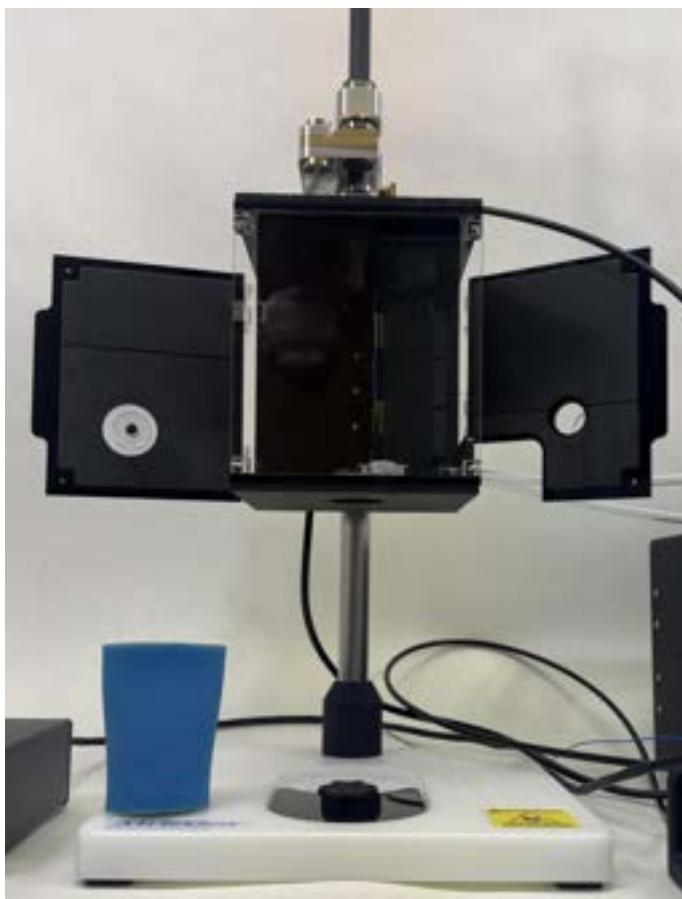


Figure 13: Proper enclosure disassembly and state for system shutdown. The humidity sock is removed and set to dry, and the enclosure doors are open

Coolant Draining

Warning: Safety glasses required

Since the coolant runs continuously in a closed loop, it is unlikely that the coolant will need to be drained between regular uses. However, for prolonged storage or transportation, the coolant should be drained. To do this, position an empty vessel behind the drain plug on the back panel of the chiller unit and proceed to remove the drain plug (see **Figure 14** below). Once the coolant has been drained, replace the drain plug (using thread tape or sealant). If desired at this point, the coolant lines can be safely disconnected from the front panel of the chiller unit, and the chiller unit and enclosure can be handled separately.



Figure 14: Draining coolant from cooling system

Appendices

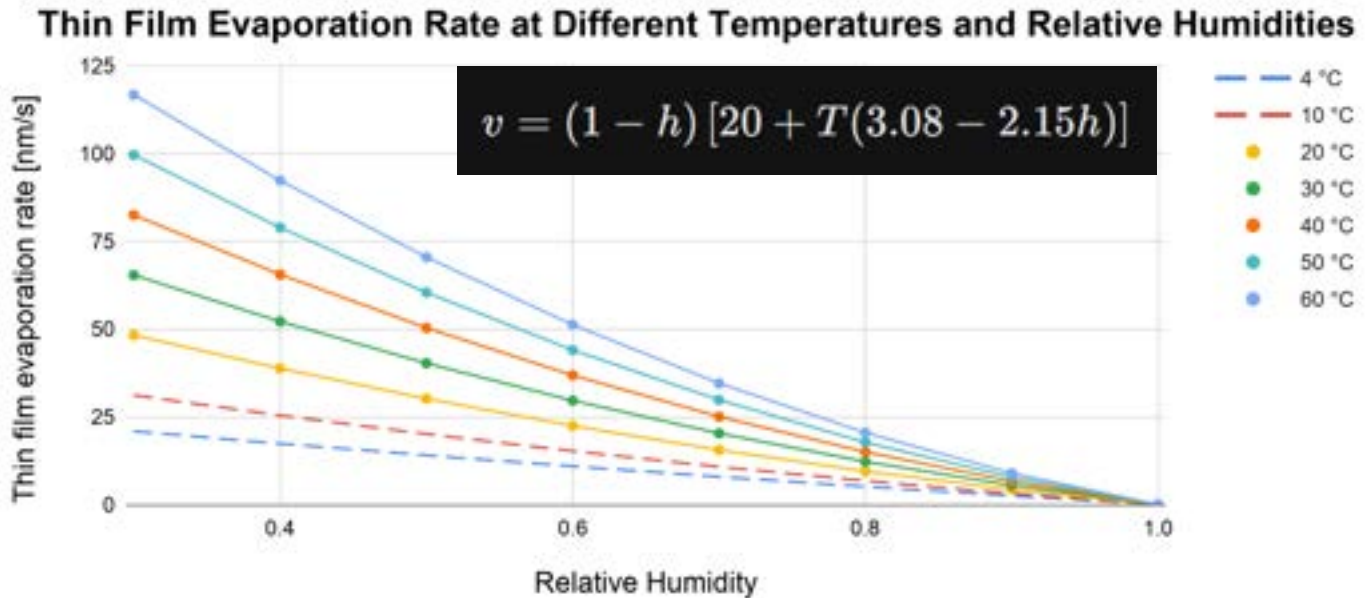


Figure A1: Thin film evaporation rate at different temperatures and relative humidities. Data for 20 °C-60 °C was obtained and reported in [1]. This data was used to obtain the equation provided above, where v is thin film evaporation rate, h is relative humidity as a proportion, and T is temperature in °C. Data for 4 °C and 10 °C conditions were extrapolated using this equation and are displayed above.

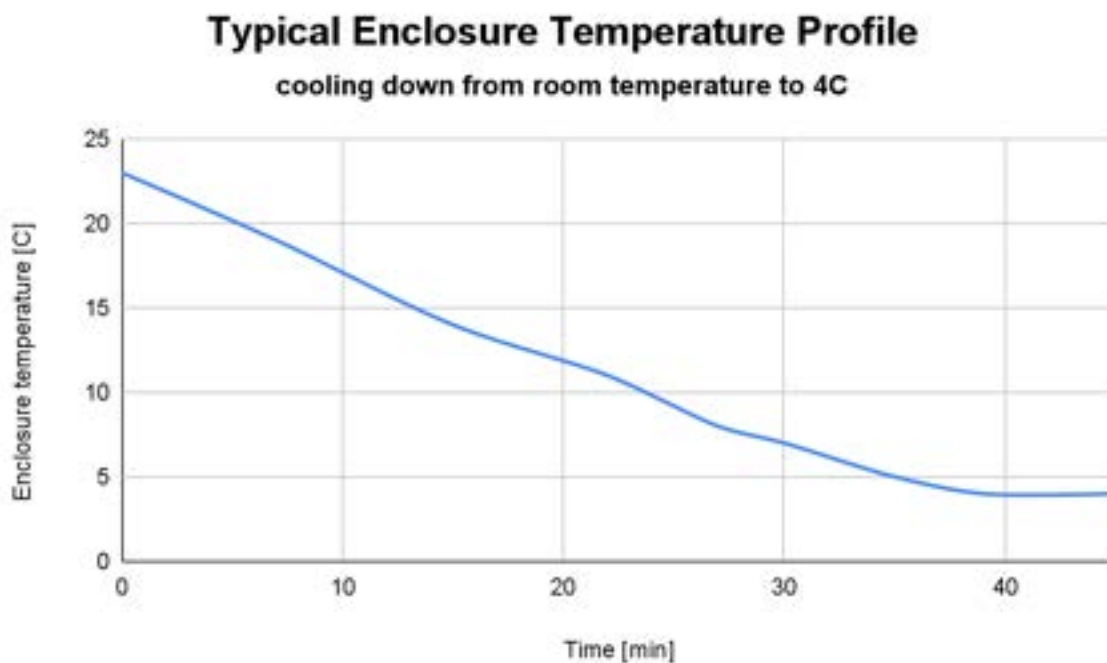


Figure A2: Typical startup temperature profile, cooling down from room temperature (23C) to 4C.

References

[1] P. M. Frederik and D. H. W. Hubert, "Cryoelectron Microscopy of Liposomes," *Methods in Enzymology*. Elsevier, pp. 431–448, 2005. doi: 10.1016/s0076-6879(05)91024-0.

We look forward to hearing about the research you perform using this equipment.

For technical assistance, please contact us:

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