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Impact of Manual Defrost vs. Auto Defrost Freezers on Sample Temperature

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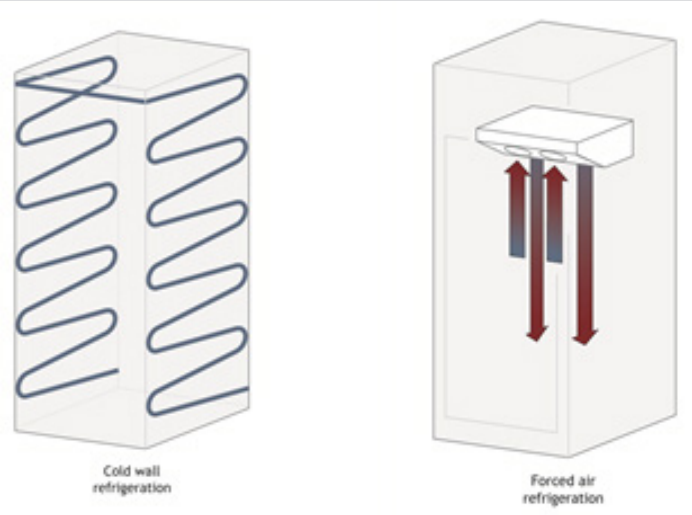
Overview

Researchers and practitioners know that stable storage temperature is important to ensure viability for frozen biological materials such as enzymes or vaccines, and that excessive time spent at out-of-range temperatures should be avoided. A common misconception is that auto-defrost freezers create an inappropriate environment for these laboratory materials compared to manual defrost freezers. This study will evaluate the performance of both technologies by testing the impact of sample temperature variability during routine door openings and during the auto-defrost process.

Description of manual defrost and auto-defrost technologies

Manual defrost freezers use cold wall technology to maintain temperatures. Cold wall freezers utilize evaporator coils sealed inside the inner walls to transfer the cold temperatures from the refrigerant to the cabinet walls. With every door opening, warm, moist air rushes to the coldest area inside the cabinet and immediately begins to build frost. Because the walls are the coldest areas exposed to moisture, frost builds up on these surfaces. This frost must be removed routinely in order to maintain proper performance of the unit. This labor-intensive, inefficient procedure requires that the unit be taken out of service and allowed to defrost. During the manual defrost process, stored items must be temporarily relocated, which exposes them to a temperature deviation and requires laboratories to always maintain multiple cold wall freezers.



Auto-defrost freezers use forced air technology to maintain temperatures. Evaporator coils are exclusively located in an enclosed housing in the ceiling of the freezer, not in the walls like in a manual defrost unit. When the freezer door is closed, a fan circulates the cold air downward from the coils and throughout the unit. This cold air has a lower humidity level which forces any ice that has formed to sublime, (evaporate without turning to a liquid). This dramatically minimizes frost build-up compared to cold wall type units. When the freezer door is opened, the fan shuts off to reduce the circulation of warm air throughout the cabinet.

During a defrost cycle, the fan shuts off and a heating element contained within the top housing automatically begins to heat the evaporator coils. The melted frost is then drained and evaporated off. Once the defrost cycle is complete, the heating coils stop and the coolant begins cooling the inner compartment before the fan is turned back on. This delay in fan re-activation prevents warm air from circulating through the cabinet.

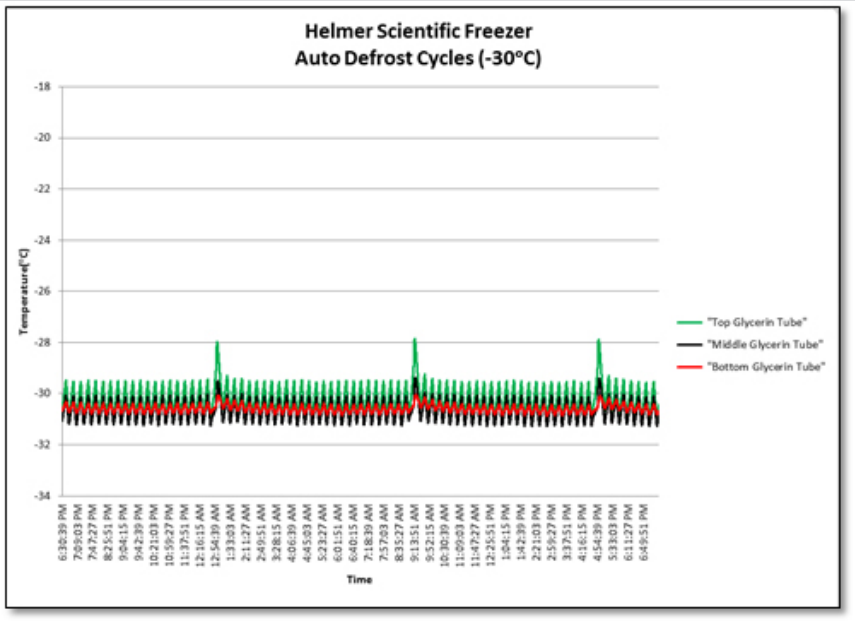
Relocating stored items during manual defrost exposes them to a temperature deviation

The delay in fan re-activation in auto-defrost freezers prevents warm air from circulating through the cabinet

Sample Temperatures During Auto-Defrost

In order to test the impact of the auto-defrost cycles, sample temperatures were measured over a 24 hour period on a Helmer Scientific 25 cu/ft freezer set at -30ºC and again at -20ºC. Three defrost cycles were performed during the testing period. The following chart demonstrates that the automatic defrost cycles had minimal impact on sample temperatures. During any auto-defrost cycle within a Helmer Scientific freezer with a set point of either -30ºC or -20ºC, sample temperatures increase by no more than 2ºC at any location within the freezer.

Helmer Scientific Freezer Auto Defrost Cycles (-30°C)



Helmer Scientific Freezer Auto Defrost Cycles (-20°C)

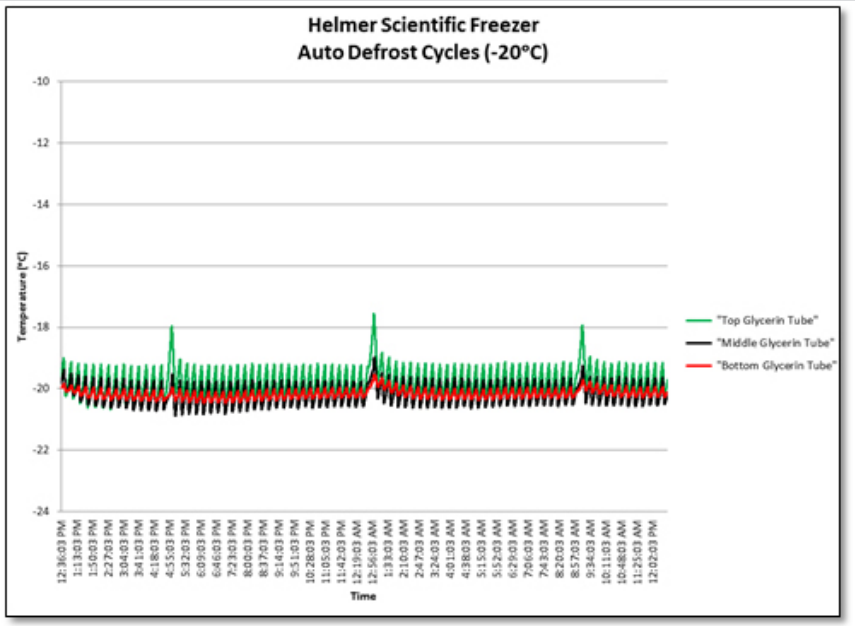


Figure 1&2 Note: Biological materials represented as 0.5ml tubes of glycerin. Temperature sensors were placed inside the samples on the top, middle and lower areas of freezer.

Sample Temperature Variability and Recovery: Door Openings

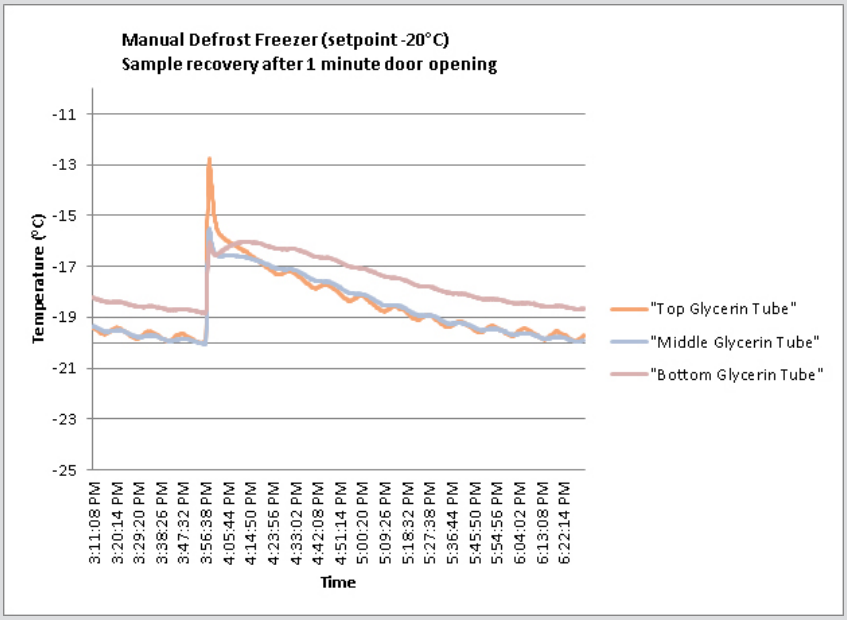
Routine door openings can have a much more dramatic impact on sample temperatures than auto-defrost cycles. Every time the freezer door is opened, warm air and moisture rush into the freezer, increasing the storage temperature.

Manual defrost, or cold wall, refrigeration units rely on passive movement of cold air and, therefore, do not respond quickly to routine door openings. Forced air units are able to move cooled air much more effectively and quickly following a door opening.

Single door opening

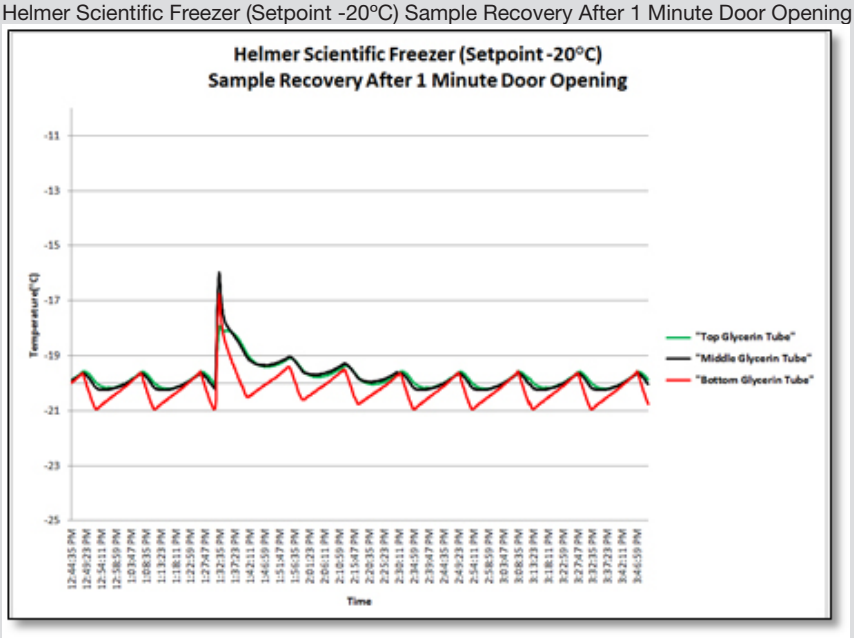
The two charts below characterize a one-minute door opening for a Helmer Scientific Horizon 25 cu/ft freezer compared to a representative manual defrost, common cold wall model. The initial temperature spike was greater for the samples in the manual defrost unit compared to the Helmer freezer, (+7ºC vs +4ºC). In addition, the samples stored in the manual defrost freezer required 2 hours and 21 minutes to return to pre-opening temperature, while the Helmer unit recovered in less than half the time.

Manual Defrost Freezer (Setpoint -20ºC) Sample Recovery After 1 Minute Door Opening



Manual defrost, or cold wall, refrigeration units rely on passive movement of cold air and do not respond quickly to routine door openings

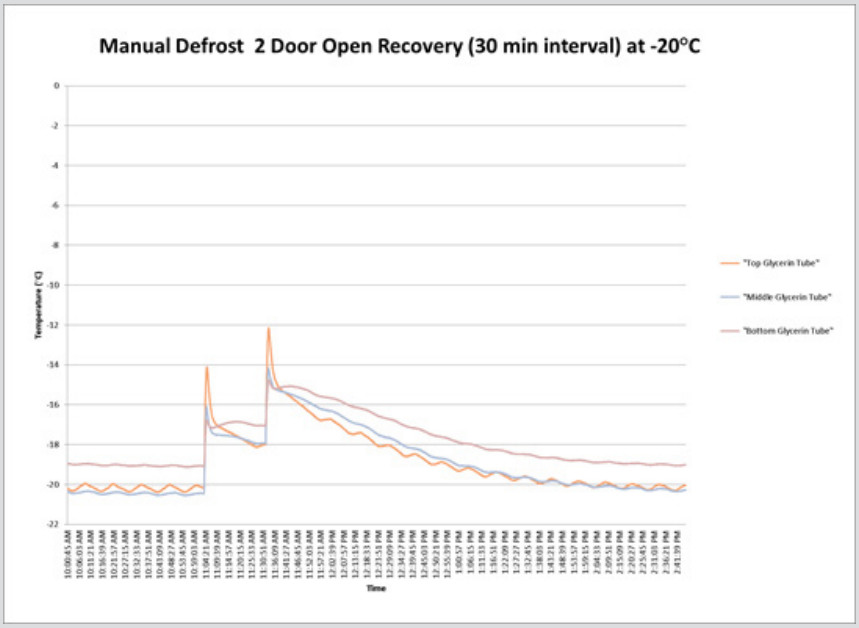
Helmer Scientific Freezer (Setpoint -20ºC) Sample Recovery After 1 Minute Door Opening



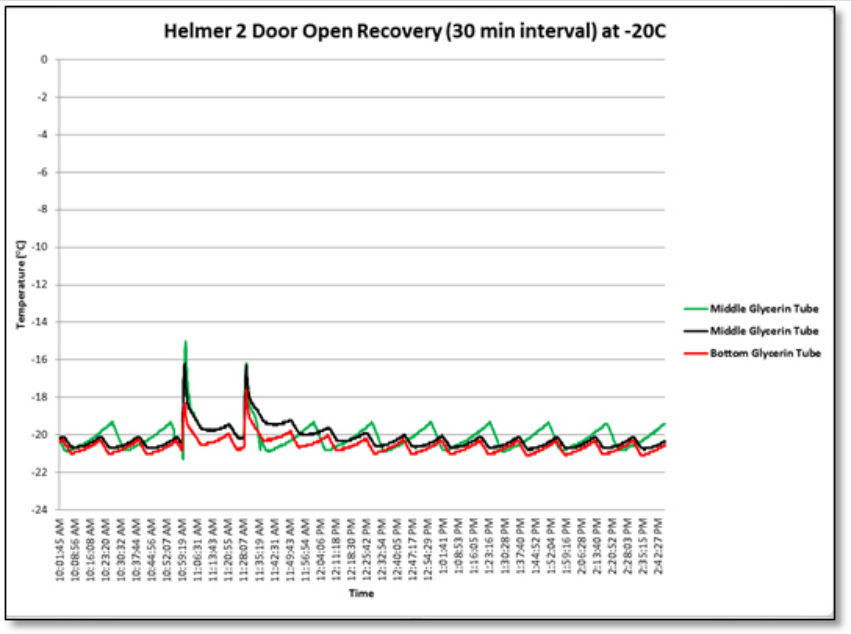
Sequential door openings

The final test simulated a routine laboratory workflow on the manual defrost freezer and the Helmer Scientific freezer. Sample temperatures were measured during two door openings occurring 30 minutes apart. In this test, the freezer door was opened for one minute and then closed. Thirty minutes later, the door was re-opened for one minute and closed again. The results of the temperature study were dramatic. The sample temperatures did not recover for 3 hours and 27 minutes in the manual defrost freezer. Recovery was much quicker in the Helmer Scientific freezer at 1 hour and 11 minutes.

Manual Defrost 2 Door Open Recovery (30 min interval) at -20ºC)



Helmer 2 Door Open Recovery (30 min interval) at -20°C)



Conclusion

The testing proves the auto-defrost process designed into the Helmer Scientific -30°C freezer is a more stable and efficient refrigeration system compared to the cold wall freezer's manual defrost process. With minimal temperature fluctuation during the defrost cycle and quick recovery time after door opening, auto-defrost ensures the secured storage of frozen biological materials. Not only are Helmer Scientific auto-defrost freezers the safest environment in which to store enzymes and vaccines, but this refrigeration system is also more efficient for the technicians and practitioners using them. Unlike manual defrost, auto defrost freezers eliminate the need for the tedious task of removing biological materials from the unit in order to melt the frost build-up, while subjecting them to temperature deviations in the process. Furthermore, without the need to remove materials stored in the freezer, there is also no need to purchase a second freezer to use as a holding zone until the original has been defrosted.

*Research data on file

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