

An Evaluation of the Impact of Inner Door Gaskets on Ultra-Low Freezer Performance

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Introduction

Researchers and clinicians rely on cold-storage equipment to maintain the integrity and quality of patient samples and other biological products. The design of an Ultra-Low freezer should be optimized to protect the stored products from unnecessary exposure to warmer temperatures. To this end, most upright Ultra-Low freezers are designed with an inner door for each shelf within the unit, in addition to a heavy-duty outer door. This effectively creates enclosed storage compartments within the freezer. The purpose of these doors is to protect the samples stored in other compartments when one of the inner doors is opened. The inner doors should be designed to effectively prevent warm air from entering the closed compartments and affecting the temperature of the products stored inside. They can also help reduce frost build-up by limiting the amount of warm, moist air that can enter the other compartments when one is opened.

It is important to understand that there are significant differences in how various Ultra-Low freezers are designed. In regards to inner doors, there is considerable variation in how they have been designed by different manufacturers. Variables include whether and how effectively the inner door is insulated, structural rigidity which helps prevent the inner doors from sagging, and the use of gaskets to seal the space around the inner doors and prevent warm, moist air from routinely entering the storage area.

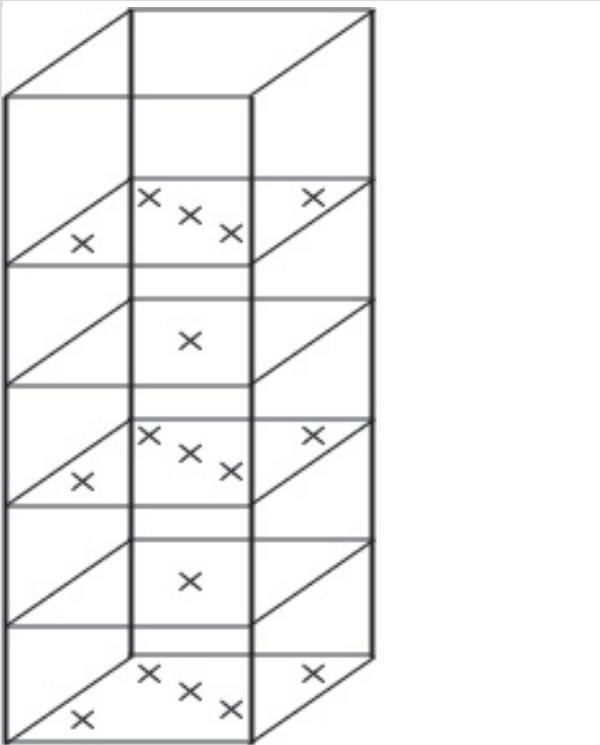
This article evaluates the difference in performance between Ultra-Low freezers that utilize gaskets to seal the space around inner doors and those that do not.

Evaluation

The evaluation protocol compared the performance of a Helmer iUF126 Ultra-Low Freezer, which is designed with inner door gaskets, to a commonly used competitive unit (the design of this unit does not include inner door gaskets). The two units were tested to determine the increase in cabinet temperature when the outer door is opened. (The inner doors remained closed throughout the test.) After opening the outer door, the temperature was recorded over time. If the cabinet temperature rose above -50°C (the normal upper operating limit for an Ultra-Low freezer), the test was stopped.

Each unit was tested with 17 T-type thermocouples in air. All the thermocouples were installed with the sensing portion approximately 2" from the surface of each shelf. Both test units had 5 inner compartments. The thermocouples were distributed throughout the compartments as shown below:

Exhibit 1. Location of 17 thermocouples used to measure air and product temperatures

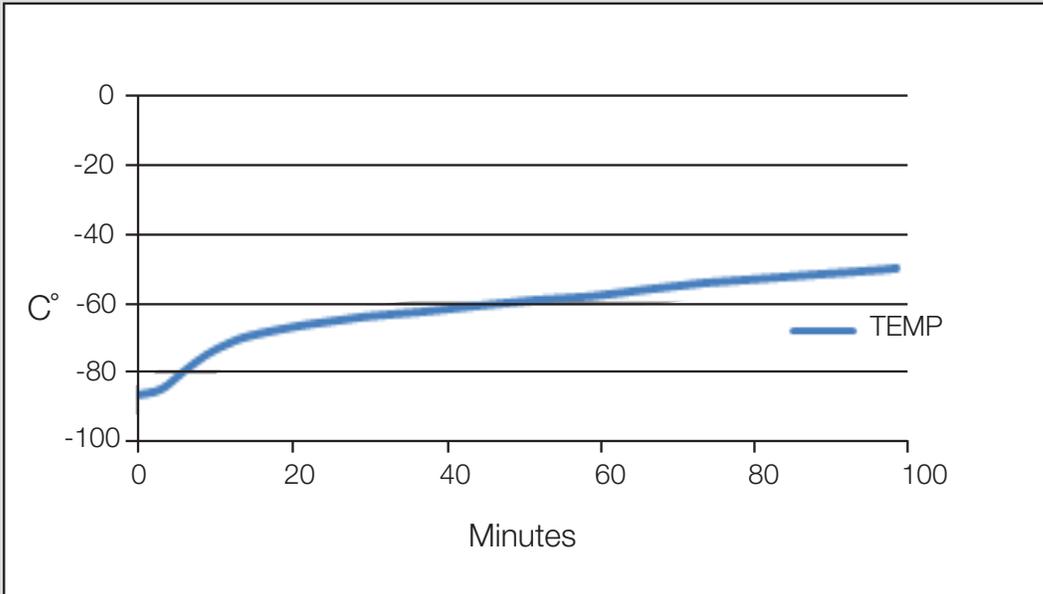


The cabinet temperature average used for these tests is the average of the individual shelf average temperatures. Time is in minutes, with 0 indicating the time of the last measurement before the door opening. Temperature is in degrees Celsius. The set temperature of the Ultra-Low freezers was -86°C and ambient temperature was 24°C , $\pm 1^{\circ}\text{C}$. The units were tested with both compressors running throughout the warm-up period.

Results

Graph 1: Temperature Performance over a 7 Minute Interval – Competitive Unit

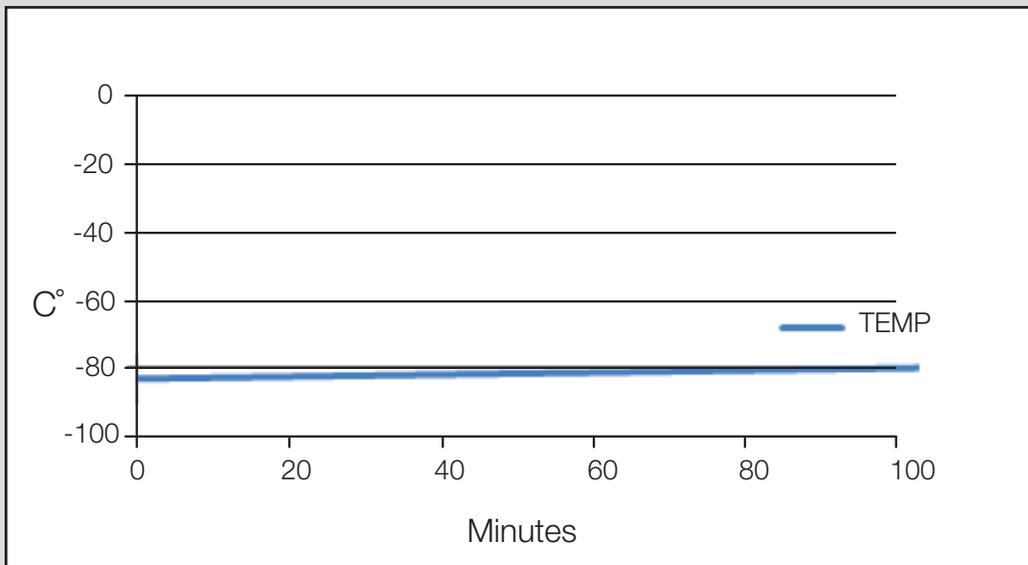
- Unit does not come with inner door gaskets
- Outer door left open



Within 7 minutes, the average cabinet temperature was -50°C.

Graph 2: Temperature Performance over a 7 Minute Interval – Helmer Scientific iUF126

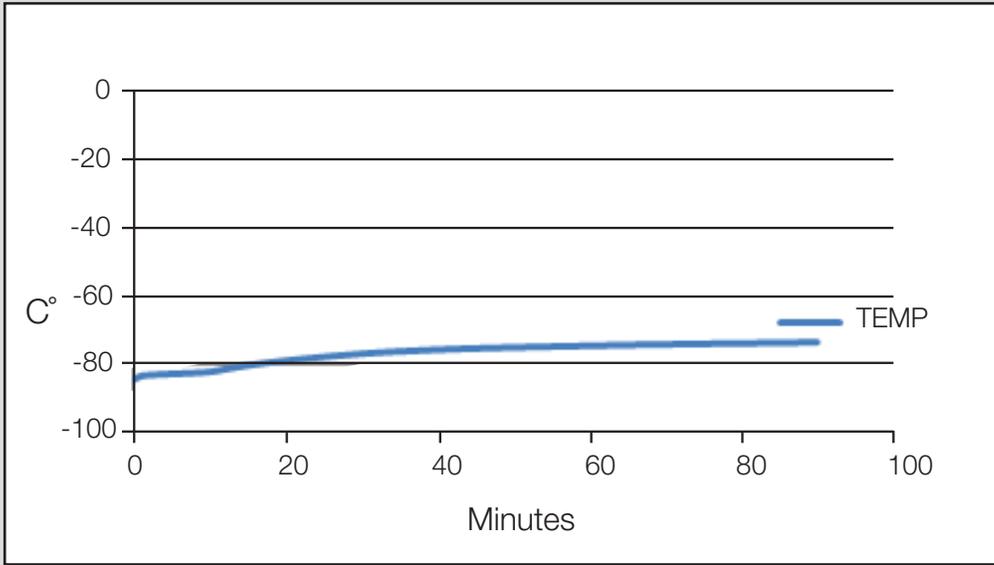
- Inner door gaskets installed (standard configuration for unit)
- Outer door left open



Within 7 minutes, the average cabinet temperature was below -80°C.

GRAPH 3: Temperature Performance over a 90 Minute Interval – Helmer Scientific iUF126

- Inner door gaskets installed (standard configuration for unit)
- Outer door left open



In 90 minutes, the average cabinet temperature was -73.2°C.

Discussion

The purpose of the inner doors in an Ultra-Low freezer is to protect the contents stored on the shelves behind each inner door (referred to as compartments). When one inner door is opened so that a user can access the products stored inside the compartment, the other inner doors serve to protect the contents in other compartments from being exposed to warm ambient air. Inner doors also help limit the amount of moisture entering the cabinet, thereby minimizing frost build-up in areas of the cabinet used for sample storage.

Exhibit 2: Summary of Temperature Performance over Time with and without Inner Door Gaskets

Model	Status of Inner Door Gaskets	Temperature after 7 minutes
Competitive Unit	Unit does not come with inner door gaskets	-50°C
Helmer Scientific iUF126	Inner door gaskets installed (standard configuration for unit)	Below -80°C

As illustrated in the summary above, there is a significant difference in the performance of Ultra-Low freezers that are designed with inner door gaskets compared to those that are not. The storage space within the competitive unit, which does not come with inner door gaskets, warmed to -50°C in less than 7 minutes after the outer door was opened. However, the storage space within the Helmer iUF126 with inner door gaskets installed (standard configuration for all Helmer Ultra-Low freezers), remained below -80°C within the same period of time. Since the protocol called for the test to be stopped after the cabinet temperature reached -50°C, testing on the competitive unit was discontinued at this time. The iUF126 was allowed to continue to run for 90 minutes. As shown in Graph 3, after 90 minutes the temperature was -73.2°C. Because of the length of time that had already elapsed without the temperature reaching -50°C, testing on this unit was stopped after 90 minutes. This evaluation demonstrates that a specific design element such as inner door gaskets can have a substantial impact on the performance of an Ultra-Low freezer. Ultra-Low freezers that do not include gaskets on the inner doors are less protective of the stored contents than are those that include gaskets. The sealing between doors is especially important to maintain inner cabinet temperature and reduce warming of the samples. Helmer uses a specially designed dual blade gasket to minimize air loss and maximize sample stability.

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