Top considerations for selecting a ULT Freezer – performance

From application to environment, there are many aspects for consideration that will impact the type of ultra-low temperature (ULT) freezer selected. Some of these aspects include: application environment, performance standards, space constraints and environment, facilities interactions, and service support. Most people jump to the hard specs first because let's face it, performance is key – and sample temperature preservation is the focus. If the freezer can't maintain the temperature as expected, then it isn't worth considering.

Key takeaways/benefits/separating features

- Understanding what is driving a performance necessity is key. Is it a want? Or is it being mandated due to a regulatory, certification standard, or validation impact? These each have different meanings and different performance implications. (See definitions and key facts at end of this document).
- Where is the unit going to be located? Noise is a key performance indicator and depending on the intended location, the noise of the unit may be more or less important.
- What type of testing, temperature mapping, or validation standards will the unit be subjected to? These types of testing protocols may have ties to regulatory standards or practices for the application (ex: pharma testing, clinical trial management). The key performance indicator here will be peak variation, but others indicators may also be involved depending on the protocol. In addition to, validation is often repeated on an annual basis (norm). Failure to revalidate can yield a freezer inoperable in the institution.
- How often will the samples or ULT freezer be accessed? Understanding the frequency of unit interaction will directly link to the door opening recovery performance needed of the unit. Also, when samples are reintroduced into the ULT freezer, what temperature will they be going in at? Typical intended use of a ULT freezer is not to "bring samples to temperature" but rather the equipment is used to "maintain temperature for long term storage". This is critical when defining the door opening recovery capacity of the system, as in most cases samples are not at -80°C (or nominal set point) when they are returned to the ULT freezer.
- Are there regulatory standards that the institution is under mandate? For example: there are specific policies like US EPA SNAP which restricts the type of refrigerants used in cold storage equipment. These can be federal or state mandated regulations. While these standards dictate the refrigeration system, the type of system has impacts on the performance as well. For example, clean (green) hydrocarbon system offer improved performance and long term reliability of ULT freezer systems.
- Are there sustainability initiatives of importance or rebate programs that are of influence? ENERGY STAR® has become a key aspect for sustainability groups. The EPA's website indicates those units which have obtained this certification – the entire family of Thermo Scientific™ TSX Series Ultra-Low Freezers is ENERGY STAR certified. In fact, Thermo Scientific has over 40 ULT freezer models registered.

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Competition

PHCBiTM VIP® ECO MDF-DU702VH Ultra-Low Temperature Freezer:

- TSX Ultra-Low Temperature Freezer is 6% better on uniformity. That means sample temperature is better controlled with less fluctuation.
- With an energy to box storage ratio, the TSX Ultra-Low Temperature Freezer holds 600 boxes vs the PHCBi™ VIP® ECO MDF-DU702VH Ultra-Low Temperature Freezer. The TSX Ultra-Low Temperature Freezer is 6% more efficient in terms of energy use per box stored.
- With 15 door openings a day, Panasonic samples could spend up to 25% of the work day at unsafe temperatures!

Stirling Ultracold™ SU780XLE Ultra Low Temperature Freezer:

- TSX Ultra-Low Temperature Freezer spends ~40% less time at warm temperatures even with more door openings.
- With only 8x door openings a day, the samples stored in the Ultracold SU780XLE ULT could spend up to >50% of the work day at unsafe temperatures!
- For a 15 second door opening, the Ultracold SU780XLE ULT takes 35 minutes to recover back to -75°C. The TSX Ultra-Low Temperature Freezer doesn't even go above the -75°C mark with a 15 second door opening. But, with a 60 second opening (4x longer and all inner/outer doors opened) the TSX ULT Freezer still recovers to -75°C faster than a Stirling's 15 second recovery time. The TSX ULT Freezer returns to temperature in 24 min. Better insulation means more capacity and safer samples.
- The TSX ULT Freezer has a 28% better cabinet temperature variation. What does this mean? Simple, you don't have to worry about where you put samples in your TSX ULT Freezer, but in Ultracold SU780XLE ULT, you have to be careful you aren't exposing samples to warm temperatures. The display on the front of the unit is not the entire cabinet. It's a single point. Understanding how the entire cabinet controls temperature variation is critical.
- The data shows the Ultracold SU780XLE ULT exhibits better energy consumption. This is undisputed. But, this is when the freezer remains shut and untouched. In this case, the TSX ULT Freezer costs ~$0.25/day more to operate. However, once you start actually using the products, the Ultracold SU780XLE ULT consumes up to 20% more energy during actual use than the TSX ULT Freezer. Using this, if you consider 2x door openings per hour for an 8hr workday (reasonable in today's lab) and you use the abnormally low 15 sec door opening times, the Ultracold SU780XLE ULT daily energy consumption moves from 6.9 kW-hr/day to approximately 8.3 kW-hr/day. That means the Ultracold SU780XLE ULT is actually only 5% more efficient than the TSX ULT Freezer. So what are you really saving – roughly a nickel ($0.05) per day? Considering all the other performance deltas, is a nickel worth it? Not to mention the Ultracold SU780XLE ULT costs more in the initial purchase!

In review

The primary job of an ULT freezer is to maintain the temperature of the samples stored within. Unlike your personal refrigerator or freezer at home, which allow large fluctuation of temperatures within the refrigerated space, temperature control in a ULT freezer is critical. Exposing samples to large fluctuations submits them to various stages of thawing and re-freezing. It's hard to believe that a sample at -80°C could be "thawing", but we're referring to molecular movement in the sample. This is a little different than the normal conception of thawing, like an ice cube melting and changing from a solid to a liquid. The TSX Series ULT Freezer has the best overall temperature uniformity and cabinet variation among energy efficient ULT freezers.

While controlling cabinet temperature is paramount, a properly designed ULT freezer also has the capacity for rapid temperature recovery from normal use. The TSX ULT Freezer recovers up to 31% faster than the other leading competitors in the market. Finally, a well-tuned ULT freezer will perform its function efficiently, minimizing energy consumption. In recent years, sustainability goals have taken the lead in equipment procurement discussions, unfortunately when this conversation trumps the needs and expectations of the real end users, the equipment can fail to deliver the needed performance the lab actually requires.

Find out more at **thermofisher.com/ult**

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