Cold storage

Critical performance factors for ultra-low temperature (ULT) freezers to consider when storing biospecimens

Storing biospecimens like tissues, cells, blood, and other biological materials is a critical aspect of biomedical research, clinical diagnostics, and biobanking. The integrity and longevity of biospecimens rely heavily on the performance of ULT freezers, which must stably maintain ultra-low temperatures to help prevent degradation of samples and preserve their viability. Several key performance metrics should be considered when evaluating ULT freezers, including temperature stability, peak variation, recovery time, energy efficiency, and operational noise. Thermo Scientific™ TSX™ Universal Series ultra-low temperature freezers offer exceptional performance across all of these critical measures.

Temperature stability

The ability of a ULT freezer to maintain a consistent temperature over time with minimal variation is known as temperature stability. Temperature stability is crucial for preventing ice crystal formation, which can damage cellular structures and compromise sample integrity during transient warming events. Traditionally, ULT freezers will have a sinusoidal temperature profile due to compressor cycling. TSX Universal ULT freezers feature advanced V-Drive technology that, when set to –80°C, will continuously run at minimal speeds when at set-point to keep the temperature stability profile flat.

Temperature uniformity

TSX Universal ULT freezers also provide excellent temperature uniformity. The high-performance insulation and uniform airflow design prevent hot and cold spots from forming in the chamber, whereas models sold by other suppliers often are unreliable in maintaining temperature uniformity. This is particularly true for larger freezers in which the difference in temperature between the chamber center and periphery can be significant.

Peak variation

A high-performance ULT freezer with minimal peak variation (PV) is important when storing biospecimens that are highly sensitive to temperature fluctuations. PV is the maximum deviation from the set temperature at any given time, and includes the most extreme temperature fluctuations even if they are brief. ULT freezers with tight PVs are well suited for facilities that must validate and qualify their own equipment. TSX Universal ULT freezers offer some of the most advantageous value across comparable cabinet-size freezers, due to their innovative V-Drive technology. They have an overall PV of less than 4°C at –80°C and have improved by up to 38% over previous-generation TSX Series ULT freezers.

Door opening recovery time

The door opening recovery (DOR) time is the amount of time a freezer takes to return to its set temperature after the door has been opened and closed, and it is often measured in minutes. Fast recovery is essential to help minimize exposure of samples to warmer temperatures, which could lead to thawing and potential degradation. Short DOR times are particularly beneficial in high-throughput sample storage environments where freezer doors are frequently opened. TSX Universal ULT freezers have rapid recovery times reaching -75°C within just 12 minutes after a 1-minute door opening with an empty cabinet—a recovery rate up to 57% faster than previous models. This can be attributed to the optimized TSX Universal ULT cooling system which quickly restores the set temperature. Many models sold by other suppliers lag in high-throughput environments, because their cooling mechanisms are less efficient.

Energy efficiency

Energy efficiency is another critical consideration, particularly in facilities that operate multiple ULT freezers. The cost of running ULT freezers can be significant, and energy-efficient models can both reduce operational costs and support sustainability initiatives. TSX Universal ULT freezers are designed with energy efficiency in mind. They utilize natural refrigerants and variable-speed compressors that minimize energy consumption without compromising performance. TSX Universal ULT freezers provide up to 33% improvement in energy efficiency over previous-generation TSX Series ULT freezers, making them among the most eco-friendly options available. The largest TSX Universal ULT freezer has a 33.5 cu. ft. cabinet and boasts one of the lowest energy consumption rates available, using just 0.24 kWh-day/cu. ft. Many smaller models from other suppliers rely on conventional refrigerants and compressors that frequently start and stop, which may make them less efficient and contribute to higher energy consumption rates.

Operational noise

Operational noise is often overlooked as a factor in ULT freezer performance. High noise levels can disrupt the work environment, particularly in laboratories with multiple freezers. TSX Universal ULT freezers are engineered to operate quietly with noise levels that are typically below 45 decibels (dB). This is achieved by incorporating sound-dampening materials and variable-speed compressors that adjust operation to minimize noise output without sacrificing needed cooling capacity. Other ULT freezers, particularly those designed with fixed-speed compressors, often generate noise at higher levels.

Durability and reliability

Build quality and durability are also crucial considerations when selecting a ULT freezer. TSX Universal ULT freezers are constructed with high-quality materials that are designed to withstand the rigors of long-term use. Their robust exteriors and reinforced internal components contribute to durability, extend unit lifetime, and reduce the likelihood of breakdowns. TSX Universal ULT freezers also come with advanced monitoring and alarm systems that can provide real-time freezer performance data, further safeguarding stored samples. These features, in addition to extensive factory testing, are why TSX Universal ULT freezers have industry-leading warranties. Other suppliers' models often have less durable builds and fewer monitoring capabilities, which can lead to higher maintenance costs and potentially put specimen integrity at risk.

TSX Universal ULT freezers stand out for outstanding performance in key areas, including temperature stability, peak variation (PV), door opening recovery time, energy efficiency, and operational noise. These performance characteristics are critical considerations for long-term preservation of biospecimens, making TSX Universal ULT freezers reliable options for laboratories, biobanks, and research facilities. Their combination of advanced technology, energy efficiency, and user-centric design makes TSX Universal Series Ultra-Low Temperature Freezers leading solutions for ULT storage needs.

Learn more at **thermofisher.com/tsxuniversal**