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COLD STORAGE RESOURCE GUIDE

Selecting the Best Cold Storage Solution for Your Lab

The costs of running the unit, as well as sample type, are key determining factors when purchasing

by Ryan Ackerman

How does the type of sample being stored influence which type of cold storage unit is ideal?

The type of sample being stored will directly affect the type of freezer required. General purpose freezers with a range of -20°C to -30°C are ideal for enzymes and biochemical reagents. Low temperature freezers in the range of -30°C to -45°C are suitable for biological samples, vaccines, and blood products. Ultra-low temperature freezers in the range of -45°C to -86°C are used for drugs, viruses, bacteria, cell preparations, tissue samples, and long-term storage. Knowing your sample type and applications beforehand will help streamline the purchase process.

How will the energy requirements of an ULT affect the overhead costs of the laboratory?

A commonly overlooked factor in the purchase of an ULT is the energy needed to operate it. ULTs must work relentlessly in order to maintain their extremely low temperatures, and in some cases a conventional style ULT can consume up to as much energy as the average American household. Over time, innovations in compressor technology, cabinet design, and insulation have ushered in an era of energy efficient ULTs which can help alleviate the energy draw—and as a result—operation costs.

How do samples that are volatile or explosive affect the type of cold storage required?

For samples and reagents which are considered flammable or hazardous (typically found in Class 1, Division 1, Group C, and Group D environments), an explosion proof freezer should be utilized. These are designed to protect lab workers, the environment, and stored materials. They include a spark-free interior and exterior, manual defrost, plug-free cords, and are CFC/HCFC free to prevent ignition of flammable or volatile materials.

SAFETY TIP

Standard refrigerators should not be used for storage of flammable or reactive chemicals. Electrical connections within the refrigerator can be an ignition source for flammable vapors. In fact, it's been reported that there are nearly a dozen sources of ignition in a standard household refrigerator. The motor under the refrigerator is also a potential ignition source. Explosion-proof refrigerators have their motor and compressor assemblies encased in an enclosure to prevent ignition. In addition, the refrigerator is wired with explosion-proof connections to the receptacle. Make sure your refrigerators are correct for your application.

MAINTENANCE TIP

Removing frost on a regular basis is important in taking care of your lab fridge or freezer as it will affect uniformity, energy consumption, and possibly product viability long-term. Having the correct voltage and regularly cleaning filters are also crucial to proper operation. In addition, users should avoid storing things on top of the fridge or freezer, otherwise air won't be able to properly circulate, and the unit will overheat.

Maintaining Your Lab's Cold Chain

Refrigerators and freezers are integral pieces of equipment in many research and clinical labs

by Erica Tennenhouse

Keeping Cool Outside of the Lab

Refrigerators and freezers are integral pieces of equipment in many research and clinical labs. Low temperatures are required to preserve samples and specimens, ensure vaccines and drugs do not degrade, and keep certain reagents from spoiling. Often, though, temperature-sensitive materials must be collected or transported beyond the confines of the lab. Maintaining the cold chain is a considerable challenge, but one that can be readily addressed with the right portable cold storage system.

Rise of the cold chain

Demand for portable cold storage is on the rise. This is being driven, in part, by the explosion of research targeting new cell therapies with the promise of personalized and preventive medicine. The clinical trials associated with this work, along with growing demand for exported plasma, necessitate the movement of samples between laboratories and health care facilities worldwide.

For manufacturers of laboratory cold storage equipment, this means an increase in requests for small cold and ultracold storage units, especially in remote clinical locations. These smaller units are ideal for storing small numbers of samples or vials without the investment or expense or large, research-style freezers.

Agents of cool

Dry ice is a common means of preservation, as it is readily available and relatively cheap. However, using containers filled with dry ice presents a temperature maintenance challenge. Specifically, when vials are placed in dry ice, only a small zone above the ice stays below –50°C. This means fragile, temperature-sensitive samples are exposed to partial thawing and freeze-thaw cycles that encourage ice recrystallization damage.

To address this problem, dry ice–based ultralow- temperature (ULT) transporters and mobile workstations specifically designed to maintain stable low-temperature work are an option. These units can keep multiple cryostorage boxes safe while critical patient samples are being collected, processed, and transferred to storage. Additionally, dry-ice is an affordable cooling agent, offering a cost-effective solution for many labs.

Liquid nitrogen (LN^2), as is another primary source of chilling capacity, with products aimed at keeping samples below their "glass transition" temperature of approximately –130°C. LN^2 dewars feature durable, vacuum-sealed, double-walled aluminum that insulates the container and limits LN^2 burn-off while providing structural rigidity for longer transport durations. In addition, there has been product innovation in novel container construction that bridges the gap between corrugated and vacuum-insulated aluminum.

As for portable freezers, technology has come a long way. The ability to have small and portable sample storage at –80°C is a significant advancement. These small, portable ULT freezers can be run off a 12-volt battery. In the event of a power failure, you could simply pick up the 40-pound freezer, move it to your vehicle, and run it for a period of time off the car battery until power is restored. This feature is particularly useful in remote locations, where emergency power might not be available.

Better products, better service

At some point, development scientists stopped thinking in terms of what's 'good enough' to keep things cold and started to use materials that allow better temperature efficiency and incorporating electronic design that allows temperature tracking and connectivity.

While the products are certainly advancing, some of the most significant advances in portable cold storage have been on the service side. There are a number of companies offering services, which has led to very robust turnkey offerings, making it much easier for end users to deal with their cold-chain needs—it can be very complicated to independently manage and verify the critical handoffs and storage.

Product Spotlight:

Eppendorf's CryoCube® F740hi is the latest addition to the Eppendorf Freezer family. Combining the high-quality tradition of our previous freezers with an increased capacity, the CryoCube F740hi stores more samples securely while maintaining optimal energy usage. The ergonomic design makes the CryoCube F740hi easier and more comfortable to use, supports an ergonomic workspace, and enables an optimal workflow in the lab.

Learn More

Cold Storage: Cold Hard Facts About Managing Your Laboratory Freezer

Cost and energy efficiency have become critical considerations when purchasing any piece of laboratory equipment, especially ultra-low temperature (ULT) freezers

by Trevor Henderson, PhD

ULT freezers represent some of the most energy- demanding pieces of laboratory equipment available and are ubiquitous in virtually every laboratory environment. When new, ULT freezers operating at their standard set points of -70°C or -80°C consume approximately 16 to 22 kilowatt hours (kWh) per day. After years of service this amount may climb to over 30 kWh per day, an amount in excess of the energy usage of the average American home according to the U.S. Energy Information Administration. For large organizations and academic institutions that may have thousands of freezers on-site, operational costs can be astonishing and even marginal improvements in efficiency can have substantial return.

When considering laboratory cold storage needs, researchers require short- and long-term sample storage solutions that maintain both reliable storage conditions and accurate temperature control. For many lab managers, however, minimizing both energy consumption and operating costs is of primary importance. Fortunately, through simple best practices for cold storage coupled with manufacturer-driven innovations in design and compressor technology, enormous savings can quickly be realized.

A place for everything

Keeping your ULT freezer organized can be a challenge.

However, consider that for every minute an upright ULT freezer door is open, it takes approximately 10 minutes for the freezer to recover to its set point. If your inventory is organized, you will greatly reduce the running time of your freezer and minimize the risks of compromising valuable samples by exposing them to fluctuating temperatures. There are several options available to assist in sample organization, including customized racking options, secondary storage containment, and electronic inventory systems that utilize bar codes or radio frequency identification. Software inventory control systems may also assist in tracking samples both in and out of your freezer while streamlining workflow and identifying old or unneeded samples that should be disposed of. For researchers who desire a fully automated solution, advanced freezers that combine inventory management software with a fully robotic vial retrieval system are an option. These systems have the ability to store thousands of samples and retrieve them quickly without the risk of accidental handling mishaps and without compromising the temperature of the containment area.

Keeping your ULT freezer properly filled can also keep operating costs down. Freezers that are too bare have little thermal mass and also may lose cold air rapidly when the door is open. This can be remedied by filling empty space with frozen gel packs or bottles full of ice. Conversely, freezers that are overfilled may lead to wide temperature variations due to passive natural convection potentially damaging sensitive samples. Keeping an accurate inventory and properly disposing of unneeded samples will keep your freezer operating at peak efficiency.

Size matters

Choosing the right size of ULT freezer for your lab may not be as simple as it seems. While smaller freezers would seem to be more efficient, in fact, small ULT freezer units operate with much higher intensity (energy consumption per cubic foot) than larger freezers do. This is owing to smaller freezers having a larger surface-to-volume ratio, coupled with the fact that smaller compressor motors are less electrically efficient and smaller compressors are less mechanically efficient than larger ones. Considering that a small 3 cu. ft. ULT freezer may operate with intensity up to 600 percent greater than a comparable larger model, it is advisable to purchase freezers with capacities of 20 cu. ft. or larger to maximize energy efficiency within the laboratory environment. If your laboratory needs are not so great as to require a full-size freezer, you may consider sharing resources with another lab and gaining some valuable floor space.

In considering size, you should also examine the sample sizes you are working with. If you are storing 0.5 mL samples using 2 mL screw-top vials, your storage is not particularly efficient. In this case, lab managers may wish to encourage or subsidize the use of micro-vials and 96-well plates. These are readily available from most distributors and can increase your sample storage capacity by nearly 60 percent.

Out with the cold, in with new

One of the fastest ways to achieve cost and energy savings is through the retirement of old or outdated ULT freezers. Technological improvements in compressor design, insulation, and cabinet design have resulted in considerable improvements in sample storage efficiencies. Be aware, however, that freezer efficiency will decrease over time owing to inadequate maintenance, seal degradation, coolant loss, mechanical failure, and degraded lubricants. In many cases, unmaintained ULT freezers may be drawing up to four times as much power as a newer or well-maintained freezer. These freezers are often neglected, sitting in hallways, and filled with unneeded or forgotten samples. Regular testing of your lab's freezers will quickly identify those in need of repair or retirement. In addition, regular maintenance is highly recommended for your cold storage equipment if you want it to age gracefully. While many small repairs, when performed early, may be relatively cheap to service, if you wait too long you may be faced with an expensive compressor rebuild or replacement.

If you are engaged in a new build, it might be advisable to consider process cooling with a chilled water loop. Ultra- low temperature freezer manufacturers (such as Panasonic) that offer optional water cooling within their cascade cooling cycle can offer dramatic savings and reduced ecological footprint for your lab. Such systems operate by removing heat from the condenser across a heat exchanger and channeling it out of the system through exiting water. This translates into less heat generation by the freezer unit, allowing for substantial savings in air-conditioning costs for the laboratory. Further, the extracted heat can be used elsewhere in the lab for water or environmental heating systems.

Thinking ahead

To properly manage your cold storage needs, it is necessary to plan for the future. Consider involving your lab in the development of a plan toward continuous improvement. This may mean developing a freezer rebate program to assist with the retirement of aging equipment or creating incentives to clean out existing space. In addition, seek expert advice from manufacturers when purchasing and maintaining equipment that is energy efficient and offers long-term investment benefits. Finally, make certain you engage all the key stakeholders in developing a management plan for your ULT storage needs; small contributions from everyone involved can amount to substantial overall savings.

Maintenance Matters: Cold Storage

Removing frost regularly is critical in laboratory freezer and fridge maintenance

People aren't concerned about removing frost from home fridges, but for laboratory cold storages freezers, this practice is important because it will affect uniformity, energy consumption, and possibly viability long-term.

Frost should be removed whenever it becomes too thick to see the inside walls of the cold storage unit. Many freezers and fridges also have indicators that show when it's time to deal with frost. Having difficulty closing the inner or outer door of an ultralow freezer is another sign to get scraping.

Having the correct voltage for your unit is also essential. Unstable voltage can cause the freezer to malfunction. For this reason, voltage must be provided at less than ±5% range. Power supply must be 25% higher than required.

The surrounding environment also plays a role. Temperature and humidity can affect freezer performance. Therefore, the environment must be maintained within the recommended conditions. Crowded rooms will tend to overheat, and the equipment will overheat with it. Optimal conditions for freezer environments are from 5-25°C, ideally 20°C, with lower than 50 percent relative humidity (RH). Always make sure there is space around the unit and that nothing is stored on top of it so air can properly circulate.

Cleaning the filters on a regular basis is also necessary. If the freezer is in a common area, the filter will need to be cleaned more often than if it is in a quiet laboratory environment. Lab workers should consider using the switchover to and from daylight savings time as a guide for when to clean filters. It typically takes less than a minute per piece of equipment to clean the filters, but it can make all the difference for equipment performance. Even better, the latest generation of freezers is filter-free, meaning users can avoid this task.

In general, users should do maintenance on their freezers at least twice a year. However, the frequency of maintenance also depends on where the equipment is placed, ambient temperatures, and humidity. Additionally, how often the fridge or freezer doors are opened during a day can also be a factor.

Common mistakes in fridge and freezer maintenance, apart from not regularly taking care of the frost and filters, include cleaning the freezer while it is up, running, and connected to a power supply; overloading the unit; using non-dedicated electrical circuits; and ignoring vertical and horizontal installation requirements. Leaving the unit's door open too long when removing ice is another common error.

WHAT YOU SHOULD KNOW BEFORE SIGNING UP FOR A FRIDGE/FREEZER MAINTENANCE PROGRAM

- Ask about the technician's installation methods
- Make sure you find out how much time will be spent when technicians make a maintenance call, as this accounts for a large portion of the cost
- What is the response time when an emergency repair call is made?
- Are backup units available if repairs are needed?
- If your samples are critical, 24/7 monitoring is usually a good service to have

Often, maintenance programs are run by regional service providers; make sure they are qualified

Strange noises, vibrations, or alarms going off are signs you should probably inspect your unit. However, it's not a good idea to wait for some alarms to go off before doing maintenance. For example, by the time a filter alarm has gone off, the filter's performance has gotten to such a severe level that it really needs to be addressed right away.

For that reason, users should make sure they understand what all of the indicators and alarms on their unit mean by reading the user's manual and consulting with technical support. In addition to those resources, the freezer engineer can be a good source of education for users at the time of installation and the Internet is always useful.

In the end, following a regular maintenance schedule and ensuring the environment is ideal are the main things users should focus on. Users should stick to a schedule and a step-by-step protocol with checkboxes when performing maintenance. They should also have a schedule for stocking and cleaning out the fridges and freezers as this will help avoid long periods of door openings while searching for samples.

Product Spotlight: Ultra-Low Freezers

PHC Corporation of North America offers an extensive selection of PHCbi brand ultra-low temperature freezers which have earned a reputation for reliability, performance and sustainability for more than 50 years. In addition to our popular VIP® Series upright freezers, new generation VIP ECO Series freezers using natural refrigerants and innovative refrigeration platforms have been independently determined to be the best performing -80C freezers on the market today in terms of critical criteria. These include temperature uniformity, fast recovery after door openings, high ambient tolerance, and energy efficiency, leading to preferred status for leading research and medical institutions throughout the world.

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Featured Manufacturer

Eppendorf

Eppendorf is a leading life science company that develops and sells instruments, consumables, and services for liquid-, sample-, and cell handling. Its product range includes pipettes and automated pipetting systems, centrifuges, mixers, spectrometers, and DNA amplification equipment as well as ultra-low temperature freezers, fermentors, bioreactors, CO2 incubators, shakers, and cell manipulation systems. Consumables such as pipette tips, tubes, plates, and disposable bioreactor vessels complement the range of highest-quality premium products.

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