

Incubators, Freezers & Cooling Equipment

ULT Freezers – Factors to Consider When Choosing a Suitable Freezer

Tracy Andrews, Product Manager, Eppendorf UK, Stevenage

Executive Summary

In the laboratory, there are few pieces of equipment that hold as many important samples as an Ultra-Low Temperature (ULT) freezer. As a laboratory's main 'Treasure Chest' they can hold anything from years of irreplaceable research, to important and often costly reagents. Therefore, the decision to purchase a new ULT freezer should be carefully researched i.e. a freezer that is suitable for one laboratory, may not be suitable for another. So which important criteria should be considered?

Energy Efficiency

Energy is a limited resource and yet it is essential for our current age. Reducing the amounts that each person uses unnecessarily is vital, to reduce fuel usage, pollution and increase cost savings. ULT freezers are run continuously at very low temperatures; therefore they will always be high energy consumers. However, some freezers will use more energy than others. A full sized ULT freezer can often use up to 22 kWh per day, which can equate to over £800 per year running costs*.



Comfort - Easy opening with new ergonomic handle that requires less force



Convenience - Quick door opening and improved temperature uniformity with new automatic vent port located within the user interface



Sample Security - Easy access to samples with new magnetic closures on inner doors

Whilst technological advances such as improved compressor, insulation and cabinet design have resulted in better performance, significant gains in energy efficiency are often made by compromising thermal stability. A balance must be found on how energy efficient a freezer can be, whilst still maintaining stable and uniform performance.

Purpose

A freezer in a high usage laboratory will need to recover its temperature very quickly, (known as pull down/recovery time) after the door is opened. If incapable of this rapid recovery, temperature stability issues may occur inside the unit. A poorly performing freezer can show larger differences in temperature, from the top to the bottom of the unit. For temperature stability throughout the freezer, good uniformity and quick temperature recovery times are essential.

Consider the materials being stored, as some materials will need quick freezing and a stable temperature. Features such as easy to open doors and ice proof latches will help improve the length of time the door remains open, thus improving the stability of the freezer.

A freezer works at its best with uninterrupted air flow inside the unit. An efficient racking system can maximise storage space whilst maintaining correct air flow and ensure the door remains open for the minimum amount of time [3].

Environment

Although they require more space than an upright freezer, chest freezers are more stable in temperature, due to the physics of cold air sinking and warm air rising. Smaller ULT freezers will have higher energy consumption per cubic foot; therefore a larger model can offer significant cost savings [1].

ULT freezers will work at their most efficient when kept in a stable cool ambient environment. Energy usage increases as ambient temperature increases; therefore an ambient temperature of 15 - 23°C is recommended [1].

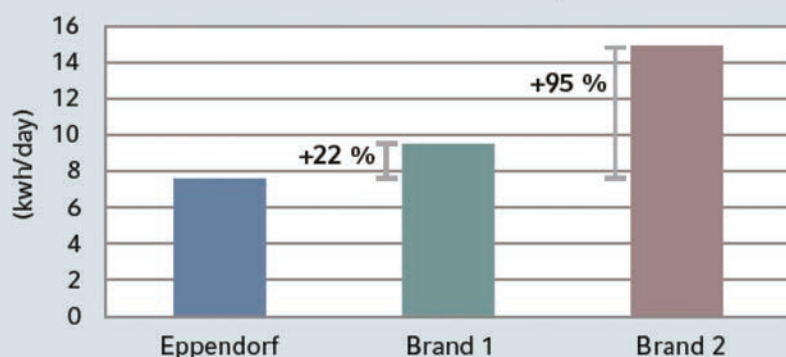
Emergency Planning

With good care and preventative maintenance a ULT freezer should provide many years of reliable service, however freezer failures are inevitable. Therefore, emergency planning is essential. A well designed freezer can take up to 40 hours to defrost completely, allowing precious time for samples to be relocated. Freezers of lesser quality construction can defrost in as little as 5 hours. Back-up freezers can also be run at minus 40 - 60°C to save on energy usage until needed.

Monitoring systems can be used to inform users of alarm events and track temperature changes. CO₂ and LN₂ back-up systems can assist in keeping the freezer cold for a number of hours. However, this is a temporary solution requiring user training, due to the health and safety considerations of dealing with these gases. Some ULT freezers use independent compressors, so that if one fails, the other will maintain the temperature at around minus 60°C. This is usually a temporary solution, allowing similar response times to freezers with superior insulation and/or CO₂ and LN₂ back-up systems.

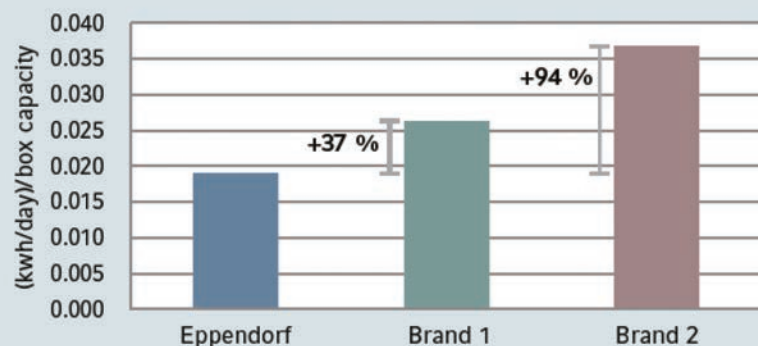
*Based on average UK kWh electricity cost.

Power Consumption



Performance tests conducted by Eppendorf in July 2014 using CryoCube F570h freezers and competitor models of comparable size, refrigerant (hydrocarbon), and capacity. All tests were performed under the same conditions at -80°C at the same ambient temperatures.

Power Consumption by Capacity



Care and Maintenance

The efficiency of ULT freezers decreases over time, due to loosening seals, refrigerant loss, degraded lubricants, fatigue in mechanical systems and poor maintenance. Freezers of superior construction will often have features to prolong working life and efficiency, such as flat soft seals which prevent ice being built up. Each year of a ULT freezer's age translates to approximately 3% increase in energy consumption [1].

Regular maintenance can help a ULT freezer reduce its energy consumption and achieve temperature more efficiently [2]. It is important to consider a manufacturer that not only has experience in producing quality ULT freezers, but is also capable of providing a professional service with fully trained engineers. Premium manufacturers provide diagnostics and maintenance features (such as easy-to-remove filter and inner doors), as well as a comprehensive warranty on parts and labour. It is also prudent to consider if a

manufacturer will have mechanical parts commercially available.

Following the guidance below, along with a suitable preventative maintenance plan, can help prolong the working life of a ULT freezer.

Good Daily Practice

- Ensuring the freezer is fully racked with a good inventory system in place, will help minimise the door open time and aid temperature recovery
- Open the minimal amount of inner doors and close immediately after use
- Ensure both the inner doors and outer doors are properly shut to prevent ice being built up.
- Remove ice built up on the doors and seals on a regular basis. This ensures the door can close properly and maintains temperature. Frost resistant gaskets will avoid ice being built up in the door seals.
- Avoid overfilling the freezer as airflow is vital.
- Airflow is just as important around the freezer. Avoid placing items on the top and blocking the air filter.
- Regular monitoring of the freezer will ensure that the correct temperature is being maintained. Temperature variance can be the first warning of a potential fault.
- Maintain a cool ambient temperature. This helps the freezer recover its temperature more efficiently after the door has been opened.

Preventative Maintenance

- Keep the air intake and grill filter clear, free from dust and debris build-up. The filter can be washed with mild soapy water.
- Check the vent tube monthly. Keep clear and free from ice that may accumulate after a prolonged period of time or extensive use. A small build-up of ice may block the vent preventing the door from opening easily. This can be removed with the manual plunger on the outside or by removing it with a gloved hand (refer to the manual).
- Keep door seals, lid seals and surfaces clean with a soft dry cloth. This will enhance the seal performance and protect internal samples.
- Keep inner doors and frames free from ice at all times.
- Use general purpose oil or spray grease on door handles and hinges to keep parts well lubricated and aid ease of movement.
- Defrost the freezer annually or when the freezer compartments have excessive icing due to heavy use. Please ensure adequate gloves are worn.
- It is important to regularly check the power fail alarms, by using the alarm test button.

For more in-depth trouble shooting, refer to the operating manual supplied with the freezer at time of purchase. Premium manufacturers should offer advice, transparent information and performance plans.

References

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