Thermo Scientific™ Ultra-Low Temperature TSX Series Freezers

High sample security, low environmental impact

White Paper

Key Words

Cold storage, sustainability, sample security, sample protection, low environmental impact, viability, rapid recovery, ULT freezers.

It's impossible to underestimate the value of your lab's samples; they represent a vast amount of work already conducted and often form the basis for a great deal of work yet to come. For this reason, laboratories have become heavily reliant upon the capability of freezers to reach exceedingly low temperatures (down to -80°C), in order to reduce any biological activity or preserve structural integrity within a sample while simultaneously ensuring that they remain viable once thawed.

Day-to-day sample protection is only part of the story though: freezers must also be capable of recovering from fluctuating temperatures as a result of inventory access and sample heat loads, while the equipment itself, and its manufacture, maintains a favourable sustainable profile. Refrigeration systems in general have had an interesting history in terms of the controversial chemicals employed as refrigerants in their earlier days, as well as them often coming with a high-energy consumption. Consequently, there has been a drive towards minimizing a freezer's environmental footprint along with the associated financial running costs.

In order to achieve what is fast becoming a tall order for ultra-low temperature (ULT) freezers, designers and manufacturers have had to develop innovative technologies to provide laboratories and scientists with devices that meet the demands of modern research.

Stable running, rapid recovery

A typical ULT freezer will be opened at multiple points throughout the working day to enable users access to the contents stored within. Any door-opening event places a heat load burden upon the freezer. It subsequently has to work hard to recover quickly from the resulting temperature change, in order to maintain a stable internal temperature and avoid any potential damage to samples. This recovery period draws upon a relatively large amount of energy, as the compressor is required to engage at full power to compensate for the rise in temperature.

The capacity of a freezer to uniformly maintain a desired low temperature across the entire cabinet in the presence of a heat load is determined by its average British thermal unit (BTU) reserve capacity. A ULT freezer with a low BTU reserve capacity will typically use less energy than a freezer with a higher BTU reserve capacity, yet these can take longer to recover from heat loads. The Thermo Scientific™ TSX series of ULT freezers has been designed to overcome this particular challenge through the development of the unique V-drive technology.

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V-drive technology enables a TSX freezer's compressor to run at variable speeds depending upon the situation, while conventional compressors are forced to continually cycle on and off. The V-drive will automatically tune the BTU reserve capacity to the heat loads presented to the freezer, meaning the compressor is not forced to quickly operate at full power when the door is opened.

During stable conditions, such as overnight or on weekends, the V-drive is designed to run at a low speed rather than switching off entirely, reducing energy consumption while also offering rapid recovery to the temperature set-point when required (Figure 1). As a result, recovery from events such as door-openings is both rapid (just 24 minutes following 60 seconds of door-opening, compared to approximately 50 minutes in a conventional refrigerant freezer) and energy-efficient.[1] This variable compressor drive is combined with automated tuning control, optimising the compressor's running speed and energy use.

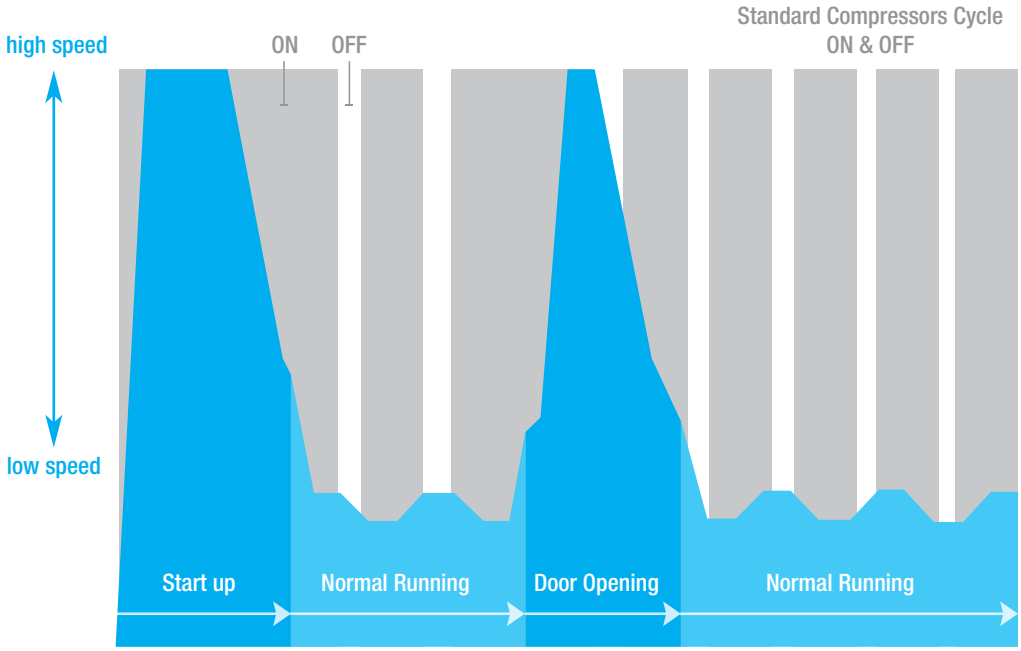


Figure 1. Unlike standard compressors that cycle on and off, V-drive adjusts to factors, such as start-up and door-openings when a higher compressor speed is needed. During normal running time when the door is closed, the V-drive runs at a lower speed to maintain a defined set-point.

In addition to offering efficient recovery during heat loads, TSX ULT freezers are designed to offer a high level of temperature uniformity when required. Maintaining a stable average internal temperature also serves to reduce a freezer's energy consumption. Switching the TSX freezer to its High Performance mode is designed to result in the internal temperature being maintained with less than 6°C of variation over the entirety of the cabinet, with the external display accurately reading this temperature within 2°C. This level of precision can be very important in specific applications that require tight thermal control.

Cool chemicals

In addition to the mechanical aspects of the ULT freezer, the choice of chemical refrigerants has a direct impact on its efficiency, with a range of potential environmental effects. Prior to the mid-1990s, chlorofluorocarbon (CFC) refrigerants were widely used in most commercial applications. CFCs, commonly known as Freon, were initially employed as very effective refrigerants that had the added benefits of low toxicity, low reactivity and low flammability. However, they were also found to be having a significantly destructive effect on the ozone layer, and in 1990 the Montreal Protocol called for the complete elimination of CFCs by the year 2000.[2] This saw a shift towards the use of hydrofluorocarbons (HFCs) as a refrigerant replacement that, while originally deemed to be better than CFCs, as they were shown not to deplete the ozone, they still showed significant global warming potential (GWP).[3]

More recently, manufacturers of ULT freezers have turned to natural, hydrocarbon refrigerants. Hydrocarbons have excellent thermodynamic properties and have proven to be very efficient refrigerants with low GWP and no ozone depletion capacity. While many hydrocarbons are flammable, various international, regional and national standards and regulations have been put in place to help minimize this risk, and to inform consumers when a product has been sufficiently tested.[4] Thermo Scientific TSX freezers employ these natural refrigerants and are designed to adhere to product safety standards, helping to ensure that end-users are safe and well informed.

Heat transfer

The heat transfer mechanism of ULT freezers is important for the overall efficiency of the unit. Many ULT freezers, including the Thermo Scientific TSX freezer, employ a direct mechanism, whereby the liquid refrigerant is actively pushed into the evaporator. Direct cooling mechanisms operate by removing heat from the cabinet through expansion of the refrigerant in a series of tubes, typically made of copper, attached to the outside of the inner tank of the unit. This tubing system is known as the evaporator, and it is the evaporation following liquid refrigerant expansion that produces the cooling effect.

Indirect mechanisms on the other hand, require the addition of an intermediate heat transfer fluid, known as the secondary refrigerant that is cooled by the evaporator and pumped to the heat exchangers (much like a building's air conditioning system in which cold water is distributed to the air coolers).

The direct cooling method used in the Thermo Scientific TSX ULT freezers allows the refrigeration system to react efficiently and quickly to door openings and sample loads.

Complying with the regulations

With so many moving parts and technologies, along with the inherent value of samples contained within a ULT freezer, it's imperative that end-users are certain that their device conforms to rigorous standards. Most modern freezers will typically carry a visual conformation of this in the form of distinct marks. The most well known of these are the CE and UL markings, both of which appear on Thermo Scientific TSX freezers.

The letters CE appear on a variety of products that are traded in the European Economic Area (EEA). The CE marking is self-declared, meaning the manufacturer has checked that these products meet EU safety, health or environmental requirements. The CE marking:

- shows that the manufacturer has checked that these products meet EU safety, health or environmental requirements
- is an indicator of a product's compliance with EU legislation
- allows the free movement of products within the European market.

The manufacturer is required to have the documentation on hand to support the claim that the unit meets the applicable directives. The placement of the CE mark may be revoked, if the product is found not to be compliant.

The letters UL mean that a representative of Underwriters Laboratory (UL) has tested the product and determined that is successfully meets the UL's requirements. UL is an American worldwide safety consulting company, approved to perform safety testing by the US federal agency Occupational Safety and Health Administration (OSHA). The UL marks appear on products and complete components, verifying their suitability for factory and field installation. In addition, Underwriters Laboratory performs periodic audits to ensure continued compliance with their standards.

Environmental and economic performance

Thankfully, the need for sustainable, environmentally friendly solutions is increasingly becoming a focus for many throughout the scientific manufacturing industry. It is fast becoming an accepted standard that the manufacturing of equipment should be associated with as small of an environmental footprint as possible, while the final device is energy, and thus economically, efficient.

The innovative design behind the TSX ULT freezers, and the inclusion of unique technologies such as the V-drive, mean that they are substantially more energy efficient than many other conventional freezers presently available. Testing showed the TSX600V for example uses less than 0.015 kWh/day per box stored. This is up to 50% less than other conventional refrigerant freezers (Figure 2). Over the course of year, The TSX600 is estimated to use 3175.5 kWh of energy each year, compared with 6570 kWh annually from a conventional refrigerant ULT freezer.[5]

Savings in energy will also result in direct savings in terms of cost (Figure 3), and a TSX600V could result in saving as much a £4,412.85 over a 10-year period.[6]

Energy savings and consumption

Figure 2.Energy saving per box stored of several popular freezers presently available.

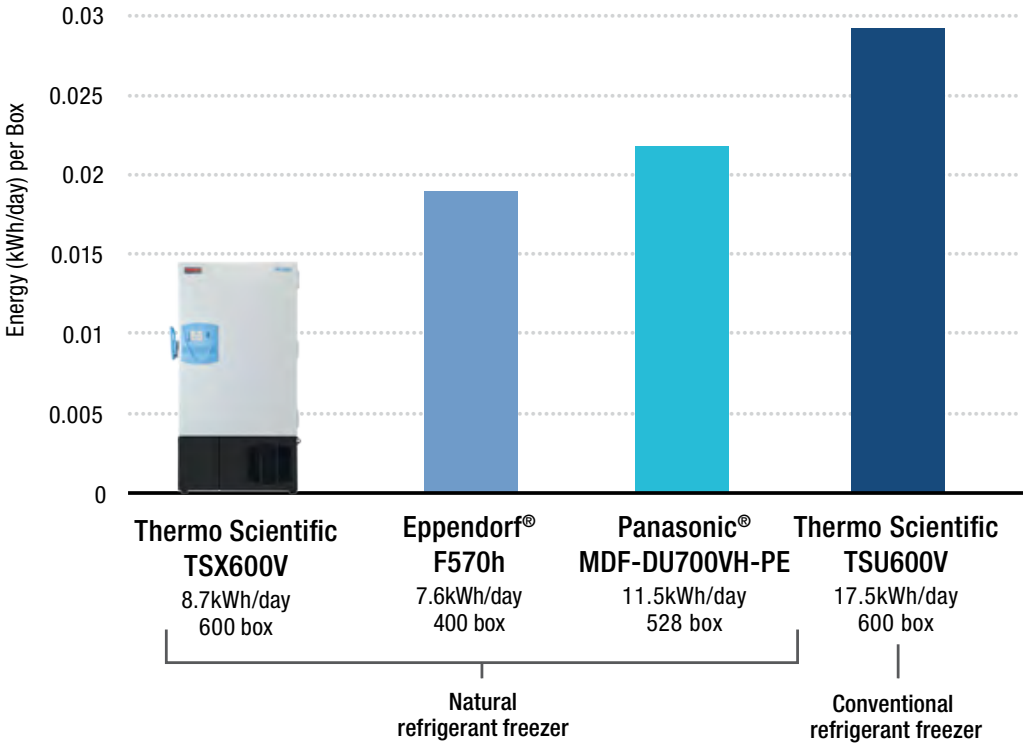
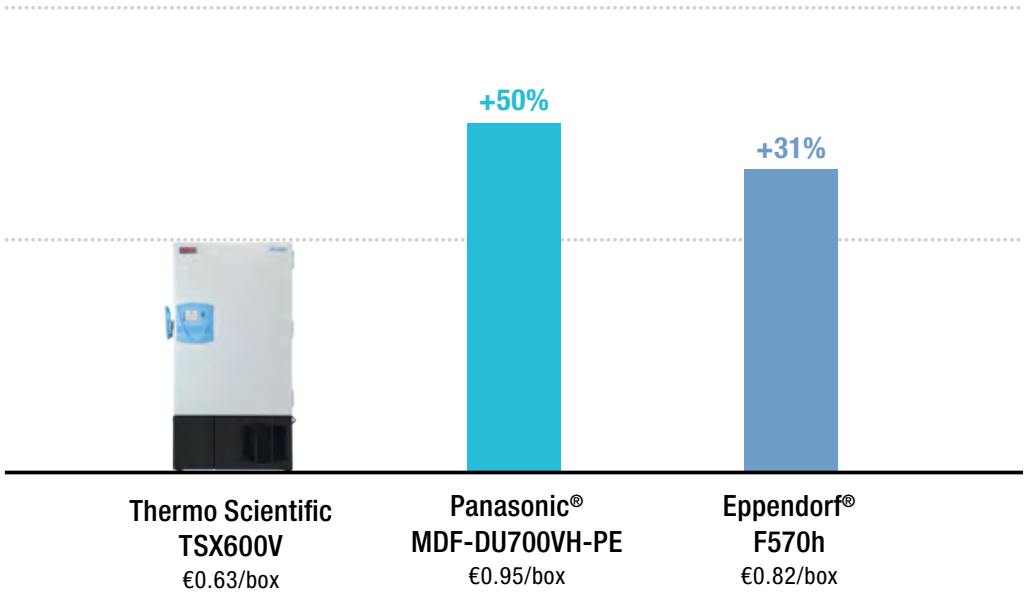


Figure 3. Cost to store one box for one year. Calculated based on manufacturer published energy consumption data as of 2/26/2015 and energy cost assumption of 0.12 euros / kWh. Energy consumption is based on manufacturer published energy consumption data as of 2/26/2015. Energy consumption is based on manufacturer published energy consumption data as of 2/26/2015.



The necessity to adopt sustainable technology is something that Thermo Fisher Scientific recognizes, and this is reflected in our green approach to the manufacturing of ULT freezers. We have made the switch to water-blown foam insulation for example, which eliminates the refrigerant out-gassing, common in other foam products. Our TSX ULT freezers are being manufactured in award-winning, zero waste-to-landfill facilities, that support 93% recycling and 7% waste-to-energy.

More than just sample storage

The Thermo Scientific TSX ULT freezer has been designed to ensure that your samples are always secure from temperature fluctuations thanks to the V-drive, its variable speed compressor capable of quickly recovering from door opening and other heat loads. It also goes beyond simple reliability, and provides users with a device constructed in low environmental impact facilities, with modern, sustainable components and a final product that has a low energy-consumption profile. These features serve to reduce both the environmental footprint and the overall running costs, while providing complete peace of mind that your samples and safe and secure.

To learn more about the Thermo Fisher Scientific and their TSX range of ULT freezers, visit: www.thermoscientific.com/tsx

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