

SPOTLIGHT

feature



Cooling & Freezing

Innovative Cryogenic In-Transit Refrigeration System Heralds in new Era

Mark Ewig, Global Strategic Marketing & Development, Linde Gases Division

The May 2012 launch of a highly innovative in-transit refrigeration system has heralded in a new era of environmentally friendly, efficient and reliable cryogenic refrigeration for road transportation of chilled and frozen perishable items.

Frostcruise® developed by Linde Gases, a division of The Linde Group, represents a major advancement for the food distribution industry in terms of this technology's ability to cope with the rigorous demands of consistently maintaining very cold temperatures. It also has significant environmental benefits.

The technology is a powerful cooling technology that indirectly uses the cryogenic effect of liquid nitrogen at a temperature of -196°C to provide rapid and evenly distributed temperature pull-down. For the laboratory sector, adequacy and condition of samples or specimens received for examination are of primary importance. If samples are improperly collected, mishandled, or, in some cases, insufficiently or unreliably chilled analysis results can be rendered meaningless. This technology is able to maintain accurate product temperature set points throughout the truck compartment, even when there are multiple delivery stops, reducing the risk of food, biological or other lab sample spoilage.

With most of the world's chilled and frozen transport undertaken by using overland refrigerated trucking, the new technology is also an excellent cost alternative to conventional diesel-powered mechanical refrigeration compartments. Its comparative environmental benefits include substantial noise reduction during deliveries in urban areas. This allows for deliveries at night or in the early hours, even in urban areas where laws usually limit noise pollution to 60–65 dB after 10:00 pm and before 6:00 am — a level which many diesel-operated refrigeration systems are unable to achieve. This represents a significant advantage for refrigerated trucking businesses, giving them the flexibility to make deliveries even at unusual times or to residential locations.

Last year, this innovative in-transit refrigeration system led the technology category of the John Connell awards from the Noise Abatement Society in the United Kingdom. The award applauds the vital role that industry plays in reducing noise pollution in the urban environment.

Existing diesel operated refrigeration systems often require drivers either to leave their vehicle's engines running while goods are being unloaded to maintain power to the on-board mechanical refrigeration units. A system of this nature demands greater fuel consumption and contributes to noise and environmental emissions in urban environments, a particularly challenging situation amid ever tightening regulations governing emissions and noise levels urban areas. There is also a risk of refrigerant leakage as high as 35% into the atmosphere, creating additional contamination and corresponding costs.

This cryogenic technology eliminates the need for vehicle engines to remain running to maintain the cooling process. This lack of reliance on the vehicle's engine also means that the refrigeration system is able to run independently in the event of a mechanical breakdown, protecting the integrity of the foods in transit.

Early Success

A key safety aspect of Frostcruise® is that it harnesses indirect cryogenic cooling. Refrigeration is housed as pure liquid nitrogen and is contained in an insulated tank mounted underneath the truck and piped through a high surface-area heat exchanger. The liquid nitrogen evaporates as high velocity fans circulate the air inside the truck compartment. From a human safety perspective, nitrogen is a natural component of air, so there are no harmful gas emissions at the user point, allowing for immediate access into the cold compartment.



Rapidly Evolving Market

While the trail system was being evaluated at MacFood Services, the Linde team noticed that the market for indirect cryogenic in-transit refrigeration was evolving rapidly, indicating very promising market potential. Linde Gases' Mark Ewig suggests this is equally attributable to legislation-driven interest in mitigating the environmental impact of diesel powered mechanical refrigeration and the need to manage the cold chain in a more cost efficient and reliable way.

"It was clear to us that a cryogenic system could meet the environmental requirement, owing to its zero carbon footprint at the point of use," he said. "When we compare carbon footprints in the in-transit refrigeration arena, we're comparing against other temperature refrigeration units (TRU). Our raw source consumption of electricity to generate the cryogenics at the air separation unit creates a carbon footprint, but once the technology arrives at the customer for implementation, its carbon footprint is zero. Effectively, this means that this technology has a 56% less carbon footprint than diesel TRU."

Conventional mechanical freezing involves diesel motors that power compressors utilising a refrigeration gas such as R404A and involves combustion occurring throughout the process. By comparison, Linde's system does not require an engine to operate, as it is powered by cryogenics. The refrigeration achieved operates at about 97% thermal efficiency, which means that virtually all the available refrigeration capacity of the liquid nitrogen is captured, with a little as 3% escaping to the atmosphere.

Said Ewig: "It all comes down to efficiency and 97% thermal efficiency is hard to compete with. Our system has only two moving parts — a valve and a fan, compared to mechanical TRU that run on hundreds of moving parts, which also creates potential for component failure."

Major Edge

While competition in the in-transit cryogenic arena certainly exists, Ewig said Frostcruise's® simplicity and cost competitiveness give it a major edge in the market place.

"Our system requires very little downtime, which equates to lower maintenance costs than mechanical refrigeration, the complexity of which also shortens its operating life. Therefore one of the key benefits of the technology is the life of the system. The longest system in operation has been going for four years, and counting, with little maintenance needed and no failures yet recorded. It just keeps on going because it's such a simple system."

"A typical mechanical system uses compressors to regulate the temperature in the cold compartment. So if you analyse this cold chain, it resembles a zigzag pattern varying plus-minus two or three degrees around the set point. For all logistics companies, holding this set point is critical, because temperature swings can compromise the integrity of the food products being transported."

"Frostcruise® utilises a modulating valve that can open from 0 to 100% to allow varying degrees of gas flow and ensure the temperature stays at the exact set point. A probe situated in the refrigeration compartment allows the driver to establish the desired temperature set point. The probe reads the temperature, sending a signal which will tell the control valve to release more cryogen into the system."

"This makes it possible to maintain a steady temperature throughout journey, invariably pegged in a plus-minus 0.5 degree window, eliminating the need for on-off adjustments. Air circulation is uniform and the positive airflow provides even temperature distribution throughout entire compartment."

"The other big benefit is the pull-down rate. Mechanical systems are typically sized to suit the refrigeration load. When you cool a truck down rapidly, you need more energy and this can take as long as 45 minutes to an hour to reach the set point."

Comparatively, this technology is effectively on-demand refrigeration. Trials in the United Kingdom conducted within an ambient temperature of 16°C proved that the system could pull the temperature down to 2°C in eight minutes. This is phenomenal, because it means temperature pull-down takes less than half the time of a mechanical system, which not only speeds up delivery

schedules, but also ensures perishable food items remain at their correct temperature, avoiding food spoilage and improving food safety. Logistics companies can now manage the cold food chain more effectively than ever before.

"I look at it as taking all the different mechanical systems out there and rolling them into one. We can provide the temperature you want and we can do it on demand, quickly arriving at a set point and maintaining it throughout the journey. Customers will see great value in this."

Low Operating Cost

Besides its carbon footprint and noise advantages, Ewig said what makes Frostcruise® so viable today is the low operating cost. He points out that typical diesel consumption is 0.7 to 1 gallon (2.6 to 3.7 litres) per operating hour, against a TRU industry average of 2000 operating hours per year. The average TRU maintenance cost is \$0.40 - \$0.55 (€0.31 - €0.42) per operating hour when the system is running.

Linde anticipates that this technology will come in at a tenth of this. The challenge right now is that the systems in operation are relatively young and haven't recorded any failures thus far. This makes it hard to come up with comparative numbers.

"However, knowing the integrity of the system and understanding which parts would need to be replaced in a failure, we can say with certainty that these costs would be extremely low compared to those relating to conventional TRU," said Ewig. "In terms of lifespan, we're looking at a longevity of 15 years and more."

"At the end of the day, a logistics company wants to distribute goods at the most competitive rate possible. Recent increases in the diesel price of and tightening noise and environmental regulations have created an ideal opportunity for cryogenics to be explored again."

Linde has obtained APT (Accord Transport Perishables) certification through Cambridge Refrigeration Technologies, determining under controlled environmental conditions the percentage of heat loss occurring during a typical delivery. APT sets common standards for temperature controlled transport vehicles such as road vehicles, railway wagons and sea containers and the tests to be done on such equipment for certification purposes.

The ATP certificate ensures that a third party has tested the insulated body and the refrigeration unit and that the two have been appropriately matched.

The Future

"We're very excited about the future of Frostcruise®," concluded Ewig. "Compared to existing technologies, it's a clear winner in terms of operating costs, on-time deliveries and product integrity, as well as being eco-friendly."

"We believe it has the potential to transform the way the world transports chilled and frozen perishable items by road."

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Compact and Economic Cooling



The new product family by **Julabo** offers space-saving and eco-friendly recirculating coolers for simple cooling applications from -10°C to +40°C.

The F series of Compact-Recirculating coolers by Julabo are ideal for simple cooling tasks in laboratories and industry. The smallest recirculating cooler of this new family, the F250, was technically up-graded to provide a wider temperature range from -10°C to +40°C.

The new recirculating coolers F500 and F1000 feature even higher cooling capacities and stronger integrated pumps. The pump of the F500 delivers 24 l/min at 0.5 bar, the stronger pump of the F1000 delivers 23 l/min at 1.0 bar.

All units of the F series feature impressive product benefits. Set points are easily entered via a 3-key-control panel. Temperatures are easy to read from a distance on the large, bright LED display. The PID temperature control guarantees a temperature stability $\pm 0.5^\circ\text{C}$. The filling port for the bath fluid is on the top and easily accessible. The integrated display shows the fluid level at a glance.

The compact, space-saving design permits flexible positioning on or below laboratory tables benches. Like every Julabo instrument, the sides of recirculating coolers have no venting slits and permit placement right next to each other or other laboratory units.

Thanks to their efficient, energy-saving operation, the compact recirculating coolers of the F series are ideal to replace cooling water. And the price is right making the purchase of a Julabo F series recirculating cooler a cost-efficient investment.

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Accurate Stylish Cooled Incubators

UK manufacturer, **LTE Scientific** has recently launched a brand new and improved family of cooled incubators to replace its Qualicool range. The stylish new IC range combines contemporary cabinet design with solid, reliable performance. In addition, all models use refrigerants R290 and R600a which have a Global Warming Potential (GWP) of just 3. This compared with lower energy consumption will help lower running costs whilst reducing your carbon footprint. Accurate temperature performance and space-efficient storage capacities are key features of the new IC range. All IC Cooled Incubators incorporate a quiet and effective fan circulation system which distributes the air evenly throughout the chamber. All models are designed to operate between +2°C and +50°C.

Three sizes are available, and all models can be supplied with either a white epoxy coated or stainless steel exterior finish. Additionally the IC200 and IC400 models can also be supplied with double-glazed glass doors. Interiors are high impact-resistant and durable ABS. The entire range also has a one piece door seal which can be easily removed making the whole cabinet extremely easy to clean.

A major feature of the benchtop/underbench IC200 model is its impressive usable chamber capacity of 80-litres, which makes it one of the largest under-bench cooled incubators available. In addition, the IC200 range can be stacked, thus making good use of floor area in the laboratory. The IC400 has an impressive 277-litre capacity yet it only takes up 595mm x 640mm floor area.

For easy maneuverability, IC400 and IC600 models are supplied on castors as standard. IC Cooled Incubators are controlled via an electronic PID controller providing close temperature control and variation throughout the chambers. For added safety, over-temperature protection is provided via a class 2 limiter.

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ULT Freezers never Looked Greener

In today's energy-conscious environment, energy efficiency is a prime concern for equipment manufacturers and users alike, and at New Brunswick it has long been a high priority. New Brunswick's ultra-low temperature (ULT) freezers are the most energy-saving in the industry and the company's new HEF® High Efficiency Freezer models are the greenest of them all. They consume up to 59% less energy than competitive units, potentially saving thousands in operating costs over the lifetime of the freezer, and have significantly less carbon impact on the environment than other systems.

ULT freezers are virtually never turned off and, compared to other laboratory systems, energy requirements can be high in order to maintain the very low temperatures necessary for sample preservation. Energy efficiency is therefore of paramount importance. This new range of HEF® freezers raises the standard for minimising energy usage and greenhouse gases, while providing superior sample protection.

Now available through **Eppendorf** sales offices.

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Precise Temperature Control of Impact Specimens

SP Scientific has introduced the CharpyCool, a low temperature bath that provides metallurgists and testing laboratories a wider range of precise temperature control for impact specimens cooling, with one of the smallest footprints on the market.

The new CharpyCool is a mechanically refrigerated bench top bath that eliminates the need for costly consumables such as liquid nitrogen or dry ice. Compact and completely self-contained, the CharpyCool offers up to 8 litres of working fluid volume enabling up to 91 Charpy impact test specimens to be accommodated at temperatures between -80°C and +30°C. A powerful variable speed magnetic stirrer and vortex breaker provide excellent temperature uniformity and stability enabling superior results. PID control enables the CharpyCool to sustain precise temperature control to within $\pm 0.1^\circ\text{C}$. The CharpyCool includes a digital temperature display, and an optional Charpy Rack is available which allows multiple-specimen loading and easy access to monitor your testing.

The CharpyCool exceeds the strict temperature stability requirements of the American Society for Testing & Materials (ASTM) Method E23 for Charpy impact testing, a standardised high strain-rate test, most often used on metals, polymers, ceramics and composites used to determine the amount of energy absorbed by a material during fracture. This absorbed energy is a measure of a given material's toughness and acts as a tool to study temperature-dependent ductile-brittle transition.

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