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Carbon Dioxide: A Natural Alternative Refrigerant

## Cold Chain Tech Trends & Outlook

## Internet of Things in HVAC

## Design of Cold Storage for Fruits & Vegetables

## Food Logistics & Global Warming

A brief analysis on how poor food logistics contributes to global warming.

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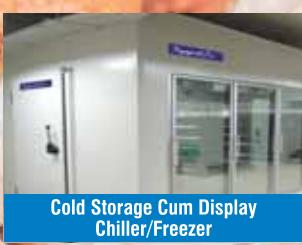
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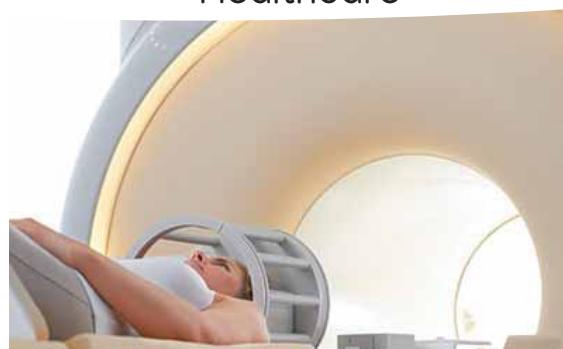
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# Publisher's Letter

Hello and welcome once again to *Cooling India*.

It is observed that around 20 to 30 per cent of the foods, with a big share of perishables, are lost due to poor handling, lack of processing, poor packing, inefficient storage, distribution, retail and transport including last mile delivery. Also, poor food logistics contributes to global warming significantly. Experts observed that, food waste could alone increase GHG emissions to 1.9-2.5 Gigatons by 2050 from 0.5 today, hence, affecting the climate change.

Thus, efficient food logistics can not only help in eliminating food insecurity, but also aid in fighting climate change. Further, cold chain is the best mode to preserve perishable food, enhance its life and availability over long periods of time. This time, we dive into how poor food logistics contributes to global warming. Our report also explains how efficient cold chain logistics can play a role in combating climate change.

Cold chain logistics is a vital link for the safe and hygienic handling of temperature-sensitive items such as agriculture produces, food items and pharmaceuticals products. Cold chain is a network of refrigerators, cold storages, freezers and cold boxes organised and maintained so that products are kept at the right temperature to remain fresh during the period of handling from factory to the point of use. However, in India, the cold chain network remains at a nascent stage.

Of late, the government has announced plans to tackle inefficient cold chain logistics and announced favourable government initiative such as subsidy schemes for setting up a cold storage facility and purchasing standalone reefer vehicles. Further, the recently launched Pradhan Mantri Kisan SAMPADA Yojana, which is designed to create world-class supply chain management from farm gate to retail outlet, will support the development of cold chain infrastructure. According to government estimate, the SAMPADA scheme alone is expected to leverage investment of Rs. 31,400 crore for handling of 334 lakh MT agro-produce valued at Rs. 1,04,125 crore.

Hope you enjoy reading this issue as always. Do send in your comments to me at [pravita@charypublications.in](mailto:pravita@charypublications.in).

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## Sustainable Solutions in Energy and Environment

### Thermax Evaporative Condenser optimizes energy savings for industrial refrigeration

In an integrated global market, how can business be managed in a competitive and sustainable environment? How can energy costs be optimised to maximise profits, and at the same time minimise the impact of business operations on the environment?

Everywhere, enterprises face the challenge of delivering high quality products and services while ensuring sufficient profit margins and contributing to the efforts of protecting the air we breathe and the water we drink. Thermax's energy efficient and eco-friendly technologies offer reliable business-to-business partnerships to respond to this critical challenge. They provide the competitive edge to your enterprise to make its mark with superior offerings.

With an immense expertise in heat and mass transfer for over five decades, Thermax has been expanding its footprint across industries globally providing energy and environment solutions. As an integral part of Thermax family, the Process Cooling division offers various industrial cooling equipment to cool, reject heat, or maintain temperature during manufacturing across different industries.

The product range for process cooling includes various wet & dry cooling solutions using air, water or a combination of both as method of heat rejection. Amongst the Wet Cooling solutions, the most preferred option for **optimising energy savings for industrial refrigeration** is Thermax Evaporative Condenser.

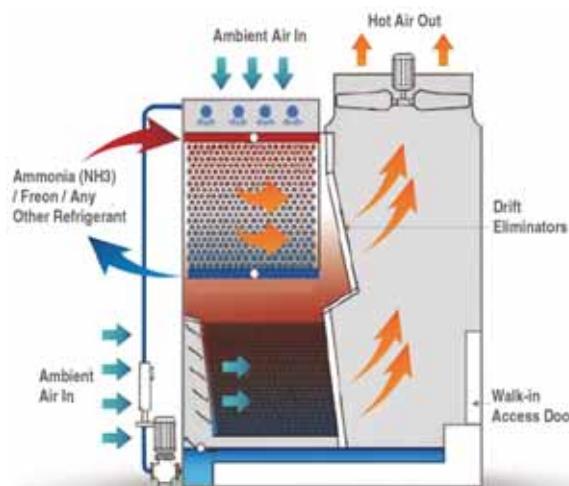
It is a great fit for ammonia / freon / other refrigerants' condensation at lower temperature. It comes in a compact size and the modular construction allows for plug and play installation. With robust corrosion-resistant structural material and serpentine continuous coil, Thermax Evaporative Condensers have quality

construction and are built to last. Thermax Evaporative Condensers offer unmatched flexibility, providing optimised selections for various refrigeration systems and climatic conditions, utilising multi-flow configuration.

#### How it works?

The refrigerant flows through the coil of the evaporative condenser.

- Heat from the refrigerant is rejected through the coil tubes.
- Part of the heat is removed directly by the downward induced air and discharged to the surrounding.
- Rest of the heat is rejected to the water cascading down over the tubes.
- Simultaneously, air is drawn in through the air inlet louvers at the base of the evaporative condenser.
- A small portion of the water is evaporated which removes the heat. The warm saturated air travels through the drift eliminator & discharged by the fan to the surrounding, thereby, reducing drift water loss.
- Post heat exchanged, the condensed refrigerant flows to receiver tank.



These innovative heat rejection products have been accepted globally and with its commendable performance made inroads across multiple industrial sectors ranging from dairies, fisheries, cold storage, meat processing, chemical, food & beverages to pharmaceutical. Process cooling business has grown multifold in last few years due to the overwhelming response from the customers.

With a wide network of sales and service across India, Thermax is there to support every step of the way from design, installation to operation.

For more info: <https://www.thermaxglobal.com/process-cooling/> or call 1800 209 0115.

To know more visit Thermax at ISHRAE's REFCOLD India – Stall B-9, Hall 1.

# EVAPORATIVE CONDENSER



## Optimizes Energy Savings for Industrial Refrigeration

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- Compact & Modular Construction

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## Aavin Dairy Boosts its Efficiency with Schneider Electric's EcoStruxure

Schneider Electric announced the successful implementation of its Aavin Dairy project with technology that can further boost its performance in the Indian dairy industry. Aavin Dairy, a Tamil Nadu Co-operative Milk Producers' Federation Limited (TCMPF) is a co-operative institution functioning in a three-tier system. The objective of the Federation is to promote the economic development of the farming community by procurement of milk from villages, processing of milk and manufacturing of milk products. Aavin recently implemented a smart manufacturing unit through Schneider's IoT enabled architecture-EcoStruxure for food and beverage.

Aavin Dairy has recently deployed Schneider Electric's EcoStruxure for food and beverage to improve productivity levels of its manufacturing unit. Schneider Electric's EcoStruxure Hybrid DCS powered by apps, analytics, services, edge control and connected products has totally integrated and automated the plant for better operational and production efficiency. It is a scalable and flexible system architecture for future capacity expansion while ensuring object-based programming for standardisation using liquid food libraries, easy maintenance and operation. Speaking on the benefits of technology deployment, Dr S Selvaraj, General Manager CDCMPU Ltd (Aavin) said, "We wanted to improve on the accuracy in milk processing and uniformity in end product quality and our plant's operational efficiency, flexibility and scalability. EcoStruxure Hybrid DCS helped us strengthen all this while improving our operational efficiency by 50 per cent since all the data is monitored and visualised and turned into actionable insights. This has improved asset management and energy efficiency, further increasing processing capacity from 2 LLPD to 3 LLPD scalable to 5 LLPD." ■

## Honeywell Steps Up Actions against Refrigerant Fakes

Counterfeit versions of a Honeywell refrigerant that is often used in car air conditioning systems have been seized in the Czech Republic.

The counterfeits are allegedly knock-offs of Solstice yf (R1234yf), a low global-warming potential (GWP) refrigerant designed to meet the needs of the automotive industry for a greener AC chemical that can reduce harmful emissions. Honeywell tipped off the Czech authorities about the unlicensed refrigerant, said to be manufactured in China, and following the seizure filed a lawsuit against a Czech distributor that it said had tried to offer the product for sale. Since then, the company has also filed two additional infringement lawsuits against a Chinese manufacturer and a Chinese distributor that it accuses of offering the suspected counterfeit in Germany.

Fake refrigerants can cause a variety of issues, ranging from increased energy use and decreased cooling performance, to significantly reducing the operating life of



your system, and causing injury and equipment failures. A prime example of the risks is a notorious incident in 2011 in which shipping line Maersk reported three cases in which refrigeration units exploded due to the use of counterfeit chemicals, causing three deaths. "Honeywell is working to ensure that our customers have access to safe and high-quality refrigerants, and we have a long history of working closely with global law enforcement agencies to stop the spread of potentially dangerous unlicensed or counterfeit products," said Richard Winick, Vice President and General Manager, Automotive Refrigerants at Honeywell. ■

## Johnson Controls to Lead Technology Integration for Nashville International Airport Expansion Project

Johnson Controls has been chosen by general contractor Hensel Phelps to deliver building-wide systems integration for Nashville International Airport's (BNA) growth and expansion plan, BNA Vision. As part of the project, Johnson Controls will also provide early engagement technology design-assist services, which are integral to determining the necessary technologies required to achieve the airport's objective: a smart, connected airport.

Using the technology contracting process, Johnson Controls will have accountability for optimising the technology plan, design, installation, integration, commissioning and service of technical systems, business applications and supporting infrastructure throughout the project. BNA's revival and expansion of its Concourse D, in addition to the Terminal Wings expansion, a key project under BNA Vision, will help the airport meet the needs

of the growing city – namely, supporting a steady increase of travelers, predicted to be 23 million by 2037. "Johnson Controls expertise in airport technology integration makes them an ideal fit to lead the building-wide systems integration of this project," said Scott Shelby, Operations Manager at Hensel Phelps. "With a project of this magnitude, it is important for all parties to understand the vision and the overall goals identified by the airport, and identify the technology required to support them, before the construction process begins. As the general contractor, it is our job to make sure that vision is brought to life."

The new, 115,000-square-foot Concourse D will feature six domestic aircraft gates, dining and retail options and a Central Utility Plant. It will also include 200,000 square feet of new space added to the north and south ends of the terminal, which will expand the Ticketing Lobby and add four Baggage Claim carousels. ■

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## Dighton-Rehoboth Regional School District Earns Trane Energy Efficiency Leader Award

Trane recognised the Dighton-Rehoboth Regional School District (DRRSD), with an Energy Efficiency Leader Award for a multi-year energy conservation program that improves classroom comfort and reduces district energy costs by 62 per cent.

Each year, taxpayers spend about USD 6 billion on energy to run K-12 schools, according to the US Department of Energy (DOE). These costs could be reduced by an estimated 25 per cent through facility updates and energy efficiency initiatives, like those at DRRSD.

The district is tackling energy waste and classroom comfort head on. "We reached a point where we had to make updates to improve the learning environment quality in our schools," said Anthony Azar, DRRSD Superintendent. "Our phased approach caused minimal disruption to our students and has already created a more comfortable place to learn." Anthony Azar and Eliza Coutour, School Committee Chairwoman, accepted the award on behalf of the district at a ceremony recently at Dighton-Rehoboth Regional High School. The district's long-term commitment to providing an energy-efficient learning environment throughout its five schools includes extensive energy conservation and facility improvements. The nearly USD 19 million in improvements will reduce at least 62 per cent reduction in energy spend, which equals approximately USD 564,000 annually. DRRSD made facility improvements with money earned through energy savings. This approach to paying for improvements to public facilities using guaranteed energy savings is known as Performance Contracting and is supported by Massachusetts state law. "DRRSD deserves this award for their commitment to conserving energy and ensuring the best environment possible for their students, said Kevin Colbert, District General Manager for Trane. ■

## Honeywell & Engie Axima Reduce Eurocontrol's Energy Consumption

Honeywell and ENGIE Axima released official data on energy and cost savings achieved from its breakthrough new cooling system for Eurocontrol, an intergovernmental organisation with 41 member and 2 comprehensive agreement states that provides air traffic management for as many as 36,000 commercial flights per day within the European airspace.

Luc De Backer, Project Implementation Manager Eurocontrol, said, "By switching from an older, less efficient cooling system to this new ENGIE Axima-Honeywell solution, we have incorporated technology that is strategically designed to meet our needs over the next two decades and future-proofs us for performance, safety, efficiency and environmental impact."

"We at ENGIE Axima always want to offer our customers sustainable, tailor-made solutions which help them use energy in an intelligent manner. The Eurocontrol project was a perfect proof of this approach," said Bernard Arimont, CEO

Engie Axima.

According to the data, the cooling system's design will help achieve annual energy savings up to 1,500 MWh and will reduce Eurocontrol's total annual consumption by more than 12 per cent.

In addition, the new cooling system is designed to prevent overheating at EUROCONTROL's headquarters and flight management and data center facilities in Brussels. EUROCONTROL's air traffic flow management and data centers require constant cooling for optimal performance and stable operations. A recent EkkoSense survey conducted in the United Kingdom found that thermal issues account for more than one-third of unplanned data center outages. The new cooling system – for which Honeywell supplied the refrigerant, and ENGIE Axima provided the equipment and servicing – is comprised of two Quantum chillers with unique remote condensers and two water-cooled Quantum chillers, achieving a total refrigeration capacity of 5 MW. ■

## Bitzer Strengthens Industrial Refrigeration Segment

For over 40 years now, Bitzer has been offering components suitable for ammonia applications and is offering larger capacities with Bitzer Ammonia Compressor Packs (ACP).

Bitzer Ammonia Compressor Packs are designed to exceed the high efficiency and reliability standards of industrial refrigeration. ACP contain compressors, motors, an oil separator and an optional oil cooling circuit as well as an optional pack of controllers and frequency inverters. Some of their components like the OS.A95 screw compressor and OAHC oil separator were exhibited at Bitzer's stand at Chillventa . Designed with a vision of providing the lowest life cycle cost to customer, each ACP can comprise up to three compressors and can achieve up to 3 MW (-10/35°C) of cooling capacity. ACP comes with discharge pressure regulator as standard and a wide variety of options including an economiser.

High efficiency at part-load is ensured

by a multi-compressor concept and intelligent capacity control of the compressors. An ACP controller in conjunction with onboard Bitzer IQ technology ensures that the ACP run reliably and efficiently for the given operating condition. The parallel circuit of the dependable Bitzer screw compressors increases operating reliability compared to industrial compressors in the same performance class. Both the controller and the most important sensors are designed with onboard redundancy and proactive control layers to increase system reliability. ACP feature exceptional starting behaviour due to their multiple compressor strategy. The starting current is reduced by approximately one-third when compared with a single compressor pack providing the same cooling capacity. This results in smaller components and lower installation costs. Monitoring the application limits with alarm and shut-off limits ensures maximum reliability. ■



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## ASHRAE & ASPE Strengthen Partnership with Signing of New MoU Agreement

**A**SHRAE and the American Society of Plumbing Engineers (ASPE) have signed a new Memorandum of Understanding (MoU) formalising the organisations' relationship.

The MoU was signed by 2018–2019 ASHRAE President-Elect Darryl Boyce, ASHRAE Executive Vice President Jeff Littleton, 2016–2018 ASPE President Mitch Clemente, CPD, FASPE, and ASPE Executive Director or CEO Billy Smith, FASPE recently. The agreement defines parameters on how the two societies will collaborate more closely to continue furthering and promoting the advancements of a more sustainable built environment.

These include but are not limited to general advocacy; research; technical committee coordination; joint conferences and meetings; training and education programs; publication distribution and chapter collaboration. "We are excited about exploring collaborative ventures with ASPE," says Sheila J Hayter, 2018–2019 ASHRAE President. "Many ASHRAE members work in firms that provide a full spectrum of mechanical, electrical, and plumbing (MEP) services. The water-energy nexus in buildings is becoming more pronounced as we push buildings to perform using integrated building design tools and techniques."

"Working with other professional societies in the broader engineering community is critical in today's fast-paced world of evolving technologies and engineering methods," says Smith. "We look forward to working together with ASHRAE to promote ongoing education, best practices, networking and new technologies for a more sophisticated and sustainable indoor environment." ■

## Tecumseh to Open New Global Technology Centre in India

**T**ecumseh Products announced their plans to establish a state-of-the-art global technology centre near Delhi. This centre is expected to further strengthen strategic partnerships and collaboration with customers, providing them with next-generation and eco-friendly compressor, condensing unit and system related technologies. The new technology centre will join Tecumseh engineering labs in the United States, France and Brazil to further support an increased focus on research, development and customer applications. After laying the foundation

stone for the global technology centre, Doug Murdock, President and CEO of Tecumseh Products Company LLC said, "We are very excited to expand our global product design and manufacturing capabilities. We are committed to supporting our customers throughout the world meet their rapidly changing local needs, industry regulations, and product requirements." In 1997, Tecumseh started its operation in India and the opening of the new technology centre reaffirms the commitment to its customers in India and surrounding markets. ■

## ACCA Joins Alabama Power in Celebrating New PAHRA Approved HVAC Training Center

**T**he Air Conditioning Contractors of America (ACCA) joined Alabama Power and business and state elected leaders Friday, October 12 to celebrate the new HVAC (heating, ventilating and air conditioning) Training Center in Jasper, AL.

The HVAC Training Center is a partnership between Alabama Power and Bevill State Community College and nearly 50 manufacturers and distributors collaborated to make it a reality.

The HVAC Training Center, which is the first of its kind to provide training on multiple types and brands of HVAC equipment, boasts 33,000 square feet of indoor facilities, including technology labs, seminar space, and classrooms. Each lab is equipped with training equipment, including heat pumps, simulators, geothermal systems, brazing, duct fabrication, whole house dehumidification systems, high-efficiency water heating, and ducted and ductless systems.

"ACCA was honored to join our partners in celebrating this state-of-the-art HVAC Training Center. The collaboration between Alabama Power, Bevill State Community College, and nearly 50 key players from the HVACR industry to provide a facility to train technicians addresses our industry's need for skilled workers. Having this training facility PAHRA accredited, making it just one of a

handful of the country's 600-plus HVACR technical colleges that is making a commitment to producing superior technicians, underscores Alabama Power's understanding of the needs of America's HVACR contractors," said Interim President and CEO for ACCA Barton James. "It is exciting to see Alabama Power and Bevill State working together to improve and enhance the HVAC learning experience," said Becky Hoelscher, Director of AC Aftermarket Sales, Emerson Commercial and Residential Solutions and Chairman of the Partnership for Air Conditioning, Heating, Refrigeration Accreditation (PAHRA). "It is great that so many members of the industry came together to support this facility through donations. The team at Emerson is looking forward to seeing the next generation of trained technicians that this facility will produce. Our hope is that schools in every state will follow this model, to help ease the constraints of the current workforce shortage."

"We are honored to work with Bevill State and our other partners to deliver this state-of-the-art HVAC Training Center," said Alabama Power CEO Mark Crosswhite. "It has been designed to provide the best possible environment to gain the expertise needed to provide superior HVAC service to customers, all while growing and elevating Alabama and its workforce." ■



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## Strand Takes Danfoss Controls Role

Kristian Strand has been elected as President of Danfoss' Refrigeration and Air Conditioning controls business. He has been promoted from Vice President, industrial refrigeration and the promotion comes after 18 months with the company and follows the departure of Thomas H Lønholdt.

Strand served Bitzer group in various senior



Kristian Strand

positions for nine years and joined Danfoss in 2017.

He joined Bitzer in 2008 as CEO of its controls company Lodam. In 2015, he moved to become Director of Bitzer's sales transport division and MD of its Finnish transport cooling division Lumikko. He later became Director of marketing and business development. ■

## Humidity Solutions Appoints Tim Gatehouse as Dehumidifier Sales Manager

Humidity Solutions has announced the appointment of Tim Gatehouse as Dehumidifier Sales Manager, with responsibility for the company's dehumidification solutions across all market sectors.

Tim has over 20 years' experience of working closely with customers to understand their business priorities and tailor each solution accordingly.



Tim Gatehouse

Tim commented, "I am very excited to be leading the dehumidification operations for a company that has such an impressive track record of delivering humidity control solutions." Sales Director John Barker added, "We have seen considerable growth in demand for our dehumidification products, so we are delighted to have Tim on board to take this area of our business forward." ■

## Fox and Caden Appointed on IoR Board

Graeme Fox, the current head of REFCOM and Jacinta Caden, Business Development Manager at Integral Refrigeration have been appointed to the Institute of Refrigeration (IoR's) board of trustees.

The record number of seven members were contending for the two available places on the board. They attracted votes from 25 per cent of the Institute's 1800 eligible voting members.

Their choices also indicated, perhaps, a desire for the Institute to be more inclusive. Graeme Fox's background is predominantly air conditioning, a sector which has been



Jacinta Caden

Graeme Fox

underrepresented in the past. In addition to her obvious experience, the choice of Jacinta Caden is particularly relevant at a time when the Institute is taking a lead role in trying to attract more women into the industry.

The trustees are responsible for the governance of the IoR, influencing its direction and strategy, ensuring it addresses the needs of membership, as well as meeting its charity objectives and legal obligations. Nine members serve as IoR trustees. Each year two new trustees are elected and two of the existing trustees stand down. ■

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## Belfast's Royal Victoria Hospital Receives Engineering Heritage Award

**B**elfast's Royal Victoria Hospital has been presented with a prestigious Engineering Heritage Award by the Institution of Mechanical Engineers which recognises its engineering importance as the first public building in the UK to be air-conditioned. The ceremony was held recently. The hospital's pioneering ventilation system fed clean air through a 400-foot-long duct to the wards, and temperature and humidity were controlled for the benefit of patients. The air conditioning system is the 122nd Engineering Heritage Award to be presented by the Institution of Mechanical Engineers.

The awards, established in 1984, aim to promote artefacts, sites or landmarks of significant engineering importance – past and present. Previous winners of Engineering Heritage Awards include Alan Turing's Bombe at Bletchley Park, the E-Type Jaguar and Concorde. Other recipients from Northern Ireland include the Short SC1 VTOL aircraft, a single-seat, low-wing, tailless delta wing aircraft, which is located in the Ulster Folk and Transport



Museum. John Wood, Chair of the Engineering Heritage Committee and Past President, said: "In 1903, the Royal Victoria Hospital's plenum air-conditioning system was the most advanced in any hospital in the UK. The system is a milestone history of environmental engineering, cleaning the air and controlling both temperature and humidity in the hospital for the comfort of staff and patients. This award recognises a pioneering engineering system in a hospital that has been at the forefront of medicine and medical technology for over 100 years." ■

## Cooltherm Receives two HVR Awards

**C**ooltherm is delighted and proud that Justin Fisher, UK Senior Projects Manager for Cooltherm has been awarded the HVR Customer Service Person of the Year Award 2018. The award is bestowed upon the person who demonstrates exceptional customer service. Justin has worked in the industry for 10 years and has vast engineering knowledge which he delivers to his customers in a kind and reassuring way.

The award was presented to Justin at a glittering awards event at The Chelsea Harbour Hotel, London. In ten years, Justin has climbed the ranks of the industry starting as a Junior Installation Engineer, to a Senior Installation Engineer and is now UK Senior Projects Manager. Justin always strives to find better, greener, smarter ways to achieve something and his customers and the environment always come first.

Rob Young, Director of Cooltherm said, "Justin is not only a credit to us at Cooltherm, but he is a credit to the whole



industry, it is people like Justin that make me proud to be a refrigeration engineer."

CoolTherm were also awarded 'Air Conditioning Product of the Year' for its development of Circlemiser. This award goes to 'the coolest new air conditioning product or the development of existing technology in the market'. The new Circlemiser chiller is one of the most efficient and innovative chillers available with unbeatable EER, SEER and ESEER performance.

The unique technology is in the design and development of special cylinder condensers and the installation of cascade flooded evaporators. The innovative Circlemiser product range uses microchannel condensers with the heat exchange surface increased by 45 per cent, compared to traditional condensers.

Dave Blackmore, Director of CoolTherm said, "We are absolutely delighted to have won HVR's award for air conditioning product of the year. It reflects a great team effort on the part of everyone involved". ■

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## HVAC System Market Expects to Reach US\$ 251.60 bn by 2023

Factors that are driving the growth of the market include increasing demand for HVAC systems for reducing energy consumption, extreme weather conditions, government tax credit and rebate programs, and growing demand for HVAC systems to upgrade old systems.



Photo Courtesy: www.hvacse.com

**A**ccording to the Marketsandmarkets research report, 'HVAC System Market by Heating Equipment, Ventilation Equipment, Cooling Type Global Forecast to 2023', the HVAC system market was valued at USD 181 billion in 2018 and is expected to reach USD 251.60 billion by 2023 at a CAGR of 6.80 per cent between 2018 and 2023. Factors that are driving the growth of the market include increasing demand for HVAC systems for reducing energy consumption, extreme weather conditions, government tax credit and rebate programs, and growing demand for HVAC systems to upgrade old systems.

In the HVAC system, a heat pump transfers heat from one point to another. A heat pump is the vital part of cooling and heating processes, which use the air available outside and inside a particular space to perform these functions. The acceptance for heat pumps is increasing owing to their evolving capabilities; these capabilities include performing both space cooling and heating functions along with the ability to heat water. Furthermore, heat pumps have higher efficiency than many other cooling or

space-heating units, which is expected to increase the demand for the same.

Air handling units held a major share of the HVAC system market for ventilation equipment in 2017. Increasing pollution levels have triggered a rise in the number of health issues among people. Hence, there is a high demand for air purifying systems such as AHUs, which can provide clean and fresh air. Although, till date, the commercial application of AHUs accounts for a major share of the HVAC system market, the market share of the residential application of AHUs is also expected to increase in the near future. The increase in urbanisation has led to the demand for smart buildings. These buildings require efficient HVAC equipment, leading to the growth of the HVAC system market. Smart buildings are not only green or sustainable but are also intelligent; these buildings are equipped with advanced technologies, which include HVAC systems. HVAC systems provide a comfortable standard living environment. Governments are relying on smart buildings, which ensure a lower carbon footprint, 40 per cent reduction in the usage of water, and less electricity consumption. Thus, developers and owners of buildings are trying to meet energy-efficiency guidelines related to HVAC systems.

Major APAC countries such as China, Japan, and India are the major consumers of HVAC systems. The governments of these countries have taken various measures to ensure that energy-efficient HVAC systems are being installed in new buildings. The collaboration of HVAC companies with major regulatory bodies is required to create awareness regarding HVAC implementation. Awareness among real-estate developers, architects, and engineers would ensure effective installation of HVAC in buildings, right from the designing stage. This would support the market for HVAC equipment. Increased awareness among consumers regarding the adoption of the star-labelled HVAC products, high use of VRV, and invertor-based AC systems have boosted the growth of the HVAC equipment market ■



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# EMBRACING A TRANSFORMATIONAL CHANGE IN A DISRUPTIVE ENVIRONMENT

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# Food Logistics & Global Warming



Image Credit: www.gep.com

A brief analysis on how poor food logistics contributes to global warming.

– Subhajit Roy, Group Editor

**F**ood logistics is an integral part of human life. Our daily needs include food, some of which are highly perishable and some of which less perishable. Logistics includes handling all types of food and the growing demand of home delivered food and online ordering, be it fresh food or frozen food, is adding to the demand on food logistics sector. It is observed that around 20 to 30 per cent of the foods, with a big share of perishables, are lost due to poor handling, lack of processing, poor packing, inefficient storage, distribution, retail and transport including last mile delivery. If all the above activities are managed scientifically, hygienically and efficiently, the food loss across the world would be minimal, opines Arvind Surange, CMD, ACR Project Consultants Pvt. Ltd. He is also a Fellow Member of ASHRAE and a past president of ASHRAE.

Activities in food logistics sector include collection of goods, material handling operation, storage, transport and delivery – the modes of transport being air, road, rail and water. These activities need mechanisation and refrigeration all of which work on energy using fuels. According to Mr Surange, "Logistics operators mainly use HFC refrigerants which have high GWP and contribute to

global warming. Usage of energy in handling, use of fuel in transport are the factors which also cause global warming. Non-availability of good road infrastructure, unreliable power, lack of trained operators, not maintaining right design conditions during storage and transport of food, improper handling are all factors which result in inefficient functioning of the logistics sector."

"On the other side", he adds, "there is higher demand for food exports, flexibility on storage and delivery methods, increase in geographical footprint of last-mile delivery services. All these result in higher use of logistics and hence resulting in higher global warming."

"Food loss and waste" refers to the edible parts of plants and animals that are produced or harvested for human consumption but that are not ultimately consumed by people. In particular, "food loss" refers to food that spills, spoils, incurs an abnormal reduction in quality such as bruising or wilting, or otherwise gets lost before it reaches the consumer. Food loss is the unintended result of an agricultural process or technical limitation of food logistics for storage, transport infrastructure, packaging, or marketing. According to Atul Khanna, India Representative, Global

Cold Chain Alliance (GCCA), "Food waste refers to food that is of good quality and fit for human consumption but that does not get consumed because it is discarded—either before or after it spoils. Food waste is the result of negligence or a conscious decision to throw food away."

Talking about how poor food logistics contributes to global warming, he said, "Agriculture releases CO<sub>2</sub>, CH<sub>4</sub>, N<sub>2</sub>O to atmosphere is expected to raise CO<sub>2</sub> equivalents to 18 Gigatons by 2050, 14 per cent could easily be avoided by better management of food utilisation and distribution due to poor food supply infrastructure. Food waste alone could alone increase GHG emissions to 1.9-2.5 Gigatons from 0.5 today, thus, affecting the climate change."

India is the second largest producer of fruits and vegetables. The government has initiated action to reduce the wastage of food and effective processing of the same. These efforts are surely showing dividends and this will eventually bring in better revenue for all farmers, said Soji Abraham, Sr Vice President, Rinac India Ltd.

He adds, "Recent studies indicate that agricultural products contribute around 12 per cent to global greenhouse gas emissions. Supporting industrial agriculture perpetuates these disturbing practices, which our government is creating awareness about amongst varied farmer groups. This is in turn is encouraging farmers to employ better farming methods and practices."

### **Efficient cold chain comes to rescue**

Cold chain is the best mode to preserve perishable food, enhance its life and availability over long periods of time. However, cold chain operation faces many challenges such as:

- Its impact on environment
- High energy usage demanded by its operations
- Substantial water requirement, and
- Shortage of trained personal leading to inefficiency in operation.

It is therefore imperative to plan, design, construct and operate cold chains using sustainable (green) features to address all the above-mentioned issues and make it utmost environment friendly and energy efficient.

Cold chain logistics based on such sustainable features would certainly play a positive role in minimising global warming. With the current industry volume and growing demand for cold chain, efficient implementation of cold chain logistics can prove to be a key factor in reducing global warming. Mr Surange outlines measures to enhance cold chain logistics efficiency:

- Use of energy efficient equipment in refrigeration and proper use of good quality thermal insulation in containers, storage chambers, packaging can ensure reduced heat and energy losses.
- Automation and controls in refrigeration system operation can increase efficiency.
- Natural refrigerants with very low GWP. For example: Ammonia, CO<sub>2</sub>, Propane, etc, and refrigerants such as HFOs need to be introduced and used more and more in logistics sector which



**Arvind Surange**

CMD, ACR Project Consultants Pvt. Ltd.

“Along with reducing food wastage, focussing on energy usage, equipment and refrigerant selection and IT and automation to increase efficiency will help in controlling global warming.

have zero or very low impact on global warming.

- Introduction of the right IT solutions like GPS tracking and monitoring, IoT based solutions for temperature and humidity tracking, routes visualisation and planning solutions can help in increasing efficiency of supply chain.
- Enabling partnerships in fragmented players across various modes of logistics and across geographies can prove beneficial.
- Use of renewable energy sources can be promoted. For example: refrigeration systems running on solar power, electric powered vehicles, etc

Thus, according to Mr Surange, "Along with reducing food wastage, focussing on energy usage, equipment and refrigerant selection and IT and automation to increase efficiency will help in controlling global warming."

Khanna of GCCA also believes, "With adequate and efficient cold chain logistics, food loss will be negligible during production, transport, storage, distribution and retail as also food waste at the consumer level due to extra servings or expiry dates or not appealing good to eyes. Thus, the carbon footprints used to produce the food will be well utilised to meet sustainable development goal of fighting hunger and emission of the gases like methane by food rotting shall also be prevented with proper cold chain which otherwise could have caused global warming."

He further adds, "Refrigeration system, of course, has to use environment-friendly refrigerants which are available with good precision towards saving environment."

### **Solar powered distribution truck**

Fuel usage for transportation and storage is another global warming potential, hence limiting to the extent is advised. The recent past has witnessed a widespread use of solar power for various types of storage and processing purposes. Detailed studies are underway to discover reductions in the usage of fuel



**Atul Khanna**

India Representative,  
Global Cold Chain Alliance (GCCA)

“Refrigeration system, of course, has to use environment-friendly refrigerants which are available with good precision towards saving environment.



ecoVan' by Rinac India

**Soji Abraham**

Sr Vice President, Rinac India Ltd.

“Many entrepreneurs are looking at the avenue of using ASRS for their storage requirements, which gives them 37% land saving, 40% power saving and low human error due to automation.

for transport refrigeration and results of these are definitely visible. One such initiative is the new solar powered distribution truck launched in India by a leading cold chain company. “The state-of-the-art transport refrigeration system ‘ecoVan’ (by Rinac India) is developed on the theme of our Prime Minister’s vision of doubling all farmers’ income by 2020. It supports this vision by aiding in the collection of produce from the farm and distributing directly to the end-user by using this refrigerated truck. One more added advantage is that this truck runs on solar power,” Mr Soji informs. This ecoVan will be displayed in the upcoming REFCOLD India at Gandhinagar, Gujarat.

**Cold warehousing**

Regarding cold warehousing, land availability at the right location is a huge impediment, due to large space requirements. New technology, with automated warehouses, is turning out to be a boon to this industry. According to Mr Soji, “Many entrepreneurs are looking at the avenue of using ASRS (Automated Stacking and Retrieval System) for their storage requirements, which gives them 37 per cent land saving, 40 per cent power saving and low human error due to automation.”

Along with these advantages, solar is being utilised as the major power source for running the refrigeration. First such multi-commodity warehouse is coming up in India under the SAMPADA scheme of the Government of India. Such storage houses will have online monitoring and control system which will provide sufficient traceability. It can also be used at different locations and linked together fluctuation in price and control the potential shortages. This is used as distribution hubs, closer to consumption spots will reduce transportation costs and will ensure better shelf life.

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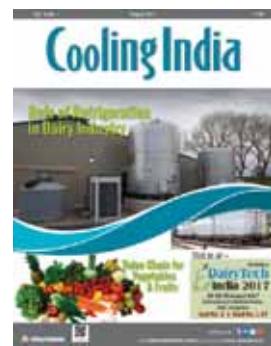
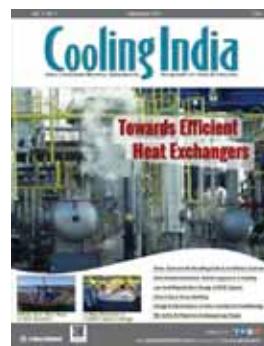


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# Indian authorities start cold chain project with Birmingham Energy Institute

**India partnership set to boost healthy nutrition and farmers' incomes by adopting clean and energy efficient cold chain technologies**

**R**esearchers from the Birmingham Energy Institute are working in collaboration with the Shakti Sustainable Energy Foundation to kick-start a programme to advance the use of new technology in Haryana and Punjab and help meet rising demand for cooling sustainably.

The programme is designed to help India achieve nutrition security and help boost farmers' incomes, with Shakti providing funding to allow researchers to carry out the vital first phase of work in creating a roadmap to clean cold success.

Professor Toby Peters of the University of Birmingham commented: "The Government of India (GoI) has put forth substantial emphasis on doubling farmers' income, by 2022. In India, up to 50% of food can be lost post-harvest primarily because of lack of cold chain. We cannot address rural poverty without cold chains extending the life of crops while connecting farmers to markets."

He adds, "A seamless cold chain will reduce food loss to raise farmers' income and give them bigger markets, whilst expanding their selling range. But at the same time, it must be clean and sustainable cooling – we must not replace a social crisis with an environmental catastrophe."

He also said, "As we migrate from fossil fuels to renewables, we need new approaches which recognise the portfolio of available resources including free and waste cold and heat. And we have to design the novel finance and business models required to create economically sustainable systems for the subsistence farmer."

Pawanexh Kohli, CEO of the national Centre for Cold Chains Development, added, "Food grain consumption is dropping worldwide, while high nutrition foods like dairy, fruits, vegetables, fish and meats are on the rise. In India alone, consumption of high nutrition foods is expected to touch half-a-billion tons by 2030. Connecting the supply of such foods with consumers leaves only one healthy recourse – the 'cold-chain'."

Researchers will work with Indian partners and State Governments, including Haryana, to develop a Centre of Excellence that demonstrates innovative and integrated solutions for creating cooling solutions for farmers without compromising climate goals.

The programme will deliver:

- A roadmap identifying the actions needed to deliver clean cold goals in India;
- A cooling services model that outlines the new technology needed; and
- In-country 'living labs' to test and demonstrate new technologies.

The first phase of the partnership will see experts:

- Assessing the energy and emissions footprints of cold-chain sector in India;
- Analysing energy and technological footprints in sectors such as food, pharmaceuticals and data storage;
- Developing a vision for the types of new cold-technology to be used; and
- Creating innovative ways of financing and implementing clean cold by linking farmers, producers, financiers and major food retailers.

Krishan Dhawan, CEO, Shakti Sustainable Energy Foundation stated: "A robust and effective cold chain system is vital to achieve the sustainable development goals related to poverty, health and hunger. By 2022, India is expected to see massive capacity addition in pack-houses, refrigeration vehicles and ripening chambers. Cold chains are expected to proliferate rapidly in the next few years through a combination of market and policy driven efforts. "Under a conventional scenario, refrigeration vehicles and pack-houses may run on diesel, which is polluting and energy inefficient technology. Leapfrogging towards a more energy efficient, affordable, and clean cold chain will reap benefits for the economy and society at large," Dhawan adds.

The programme launch and workshops follow an agreement signed in May between the University and the State Government of Haryana to advance the use of 'clean cold' technology in India and help meet rising demand for cooling sustainably.

This will develop a centre of excellence to help map out a blueprint and delivery plan for sustainable cooling across the north Indian state. The agreement builds on the University's work with collaborators in India to understand how to deliver sustainable refrigerated distribution chains to help boost farmers' income. ■



Image Credit: www.oceasoft.com

The article gives a glimpse of latest cold chain technology trends and future industry outlook.

- Supriya A Oundhakar, Associate Editor

**T**he cold chain industry in India has gained momentum with new investments in cold storage as well as in logistics. The cold chain industry has brought about a remarkable shift in India, with a change from seasonal to perennial market. The cold chain industry has become an essential part of the supply chain industry comprising refrigerated room or storage and refrigerated transportation. The cold storage facilities enhance shelf life of perishable foods by retaining desired temperature of the storage products from farm to end user. In the absence of proper cold storage and related cold chain facilities, agriculture and horticultural produce goes waste due to post-harvest losses and poor and inadequate infrastructure for perishable products. Post-harvest losses for fruits and vegetables were as high as 18 per cent and 12 per cent, respectively, according to Ministry of Food Processing Industry in the absence of enough cold storages for fruits, while for vegetables, lack of adequate reefer vehicles leads to transportation losses.

A per the National Centre for Cold Chain Development, as against a requirement of 61,000-62,000 reefer vehicles, only

9,000 vehicles are available. There are many reasons for this: Lack of first- and last-mile connectivity, stiff competition, low margins, and low preference of end-users for reefer vehicles due to higher cost and unavailability of return load, which leads to inefficient utilisation of vehicles.

According to the Ministry of Food Processing Industries data, India's cold storage capacity stood at 35 million tonnes (MT), as of July 2017. Single-commodity (potato) cold storages accounted for 68 per cent of the volume. Multi-purpose cold storages are expected to increase their share (volume) from 32 per cent to 43 per cent by fiscal 2023, states Hetal Gandhi Director, Research, CRISIL.

A report from National Cold Chain Development (NCCD) submitted during 2015 indicates around 70,000 pack houses, 32,00,000 MT storage, 52,000 reefer vehicles and 8,000 ripening chambers are required. Currently, developments in the last three years have reduced the figures.

While taking a note of trends in the cold chain industry, C Subramaniam, National President, Indian Society of Heating,

Refrigerating and Air Conditioning Engineers (ISHRAE) states, that several cold storage projects are in various stages of proposals or development. Cold storage with grants received earlier have been commissioned and are already being used. Many states in India are also encouraging investors to set up cold storage. Market predicts 10 per cent to 15 per cent CAGR every year for the next five years. Value wise it is estimated as INR 1000 billion last year to INR 2250 billion by 2023.

Gandhi says, "Players are increasingly investing in multi-purpose cold storages, which have lower payback period – typically about six years, or nearly half of that for single-commodity ones – and command higher margins. In the past year, organised players have also started putting their money in integrated models that combine temperature-controlled warehouse (TCW) and temperature-controlled vehicle (TCV) services to diversified end-users."

Energy conservation, green manufacturing techniques, eco-friendly refrigerants etc have gained significance during selection of a cold storage. Positive temperature stores are required for perishables like fruits and vegetables, milk and dairy products, seeds, food at various stages, medicines, frozen and fresh marine, meat, etc. For completing the cold chain - farm to fork - pack house, with washing, grading and sorting of produce and precooling (removal of field heat) at the farm, refrigerated transport to the cold warehouse, reefer transportation to distribution cold rooms and to display counters at retailers and finally the refrigerators at homes - all are essential requirements of a cold chain. Door delivery to customers in eco-friendly last mile temperature-controlled delivery vehicles are being used to maintain refrigeration of products.

According to Shiv Kumar, Country Marketing Manager, Fujian Snowman, "Cold chain industry is undergoing consolidation and becoming organised pattern from scattered and unorganised form. In present scenario, we witness more responsible contribution, sensitivity towards environment and energy efficient solutions by stakeholders like end users, contractors, OEM and consultants."

Demand is on the rise across the value chain, given changing consumer needs, growing penetration of quick service restaurants (QSRs), and expanding organised retail. Growing exports of processed fruits and vegetables, seafood, and meat also magnifies the need for organised cold storages and reefer vehicles, as stringent food safety norms in importing countries demand cold storage along the entire supply chain of export commodities.

The ready-to-eat food industry supports the fast food industry. The marine and meat industry is also on the growth path. Pharma sector has been witnessing rapid growth. All these sectors require blast coolers, blast freezers, Individual Quick Freezer (IQF), plate freezers, tube ice and flake ice machines, cold storage and reefer transport for both positive and negative temperature etc all of which driving the cold chain industry.

According to C Subramaniam, "The shelf life of seasonal produce varies and many have low and mid shelf life even under



### C Subramaniam

National President, Indian Society of Heating, Refrigerating and Air Conditioning Engineers (ISHRAE)

“Market predicts 10 per cent to 15 per cent CAGR every year for the next five years. Value wise it is estimated as INR 1000 billion last year to INR 2250 billion by 2023.

conditioned atmosphere. Fruits and vegetables with exception of onions need to be maintained at higher relative humidity in addition to temperature control. For low shelf life produce, individual quick-freezing process is commonly used to freeze the fruits like mango, papaya, musk melon etc in small cubes of sizes less than or equal to 10 mm, similarly vegetables like green peas, corn, cut beans, cut carrots, cut broccoli, cut onions, cut ladies finger all in cubical form are frozen, stored, shipped and sold. The exposure to and consumption of fast food and the various combinations available in the ice cream sector have created a demand for this sector.”

Significant growth is anticipated in storage sector and this would be due to the major growth in the organised retail industry, commodity markets and growth in industrial manufacturing and development. The cold chain industry is rising with major advancements and growth in the food processing sector and organised retail coupled with government initiatives that are driving the industry forward. A number of food parks have been commissioned in India and logistics and supply chain management form an integral part of these food parks. Many large food parks on the PPP model of financing would soon alter the economy of the country.

While talking about the growth drivers of the cold chain industry, Chandrakant Patel, Chairman-cum-Managing Director, Ice Make Refrigeration, says, "The rise would be complemented and supported by the rising retail in India which would generate huge infrastructural demand resulting in increased levels of revenue for the cold chain industry. The key growth drivers in this growth in cold chain industry includes growth in organised retail and food service industry, government's initiatives, rising export demand for processed, frozen food, confectionery and meat



### Hetal Gandhi

Director, Research, CRISIL

“It is expected that the industry will grow 13-15 per cent in value terms annually over the next five years, riding on demand from QSR, meat, seafood, bio-pharmaceuticals, organised retail, and exotic fruits and vegetables. Multi-purpose cold storages are expected to increase their share (value terms) from 80 per cent to 87 per cent by fiscal 2023.



## **Chandrakant Patel**

Managing Director, Ice Make Refrigeration

“Advance tracking abilities give relevant parties advanced warning of any changes or malfunctions with the equipment. These types of notifications can help to ensure necessary maintenance is performed regularly or even secure alternate capacity before a load is compromised.

products.”

## **Technology**

Advanced technology is leveraging the growth of cold chain industry. Various technologies continue to have an impact on the cold chain industry. While giving a glimpse of the latest trends in technology, Patel informs, “Among various technologies, there is a noticeable movement towards alternative transport refrigeration systems with thermal energy storage plate for multi-deliveries of ice cream, frozen food, bakery and confectionaries products and fruits and vegetables. It offers significant noise reduction benefits as well fuel saving.”

CRISIL informs that organised multi-purpose storages have adopted environment-friendly refrigerants such as freon and diverse technologies ( $\text{CO}_2$  scrubber, vacuum-pressured swing absorption, nitrogen generator, etc) depending on the nature of the commodity, type and stage of processing, and extent of sophistication of value chain. Freon is used only in 30 per cent of cold storage setups at present, though the proportion is on the rise.

“Leakage of ammonia could cause deterioration in the quality of the stored produce. Therefore, freon is preferred in predominantly exported products such as meat and seafood, while ammonia is used for packed dairy products and pharmaceuticals. However,

cold storage systems that are 10-15 years old have low adaptability to new technology, and therefore, need a complete overhaul. Also investment in freon technology is around 1.5 times that required for ammonia,” states Gandhi.

Shiv Kumar from Fujian Snowman notes that the compressor market is driven by three factors like energy efficiency, environment friendliness and sustainability. Environment friendliness and lower Global Warming Potential (GWP) are the drivers for R&D department of any compressor manufacturers.

Industrial Refrigeration (IR) seems to be an easy sector regarding low GWP refrigerants, but Shiv Kumar still notices potential pitfalls as well as room for innovation. Due to low GWP,  $\text{NH}_3$  has been preferred refrigerant in IR, having a negative aspect of toxicity. Natural refrigerants like  $\text{NH}_3$  and  $\text{CO}_2$  are still preferred by users, companies like Fujian Snowman are working on lowering the charge of  $\text{NH}_3$  in the refrigeration system by adding cascade method and secondary refrigerant method using  $\text{CO}_2$  for circulating inside the larger cold-storages.

According to ISHRAE, variable frequency drives for various electric motors are used for energy saving in different applications. Solar energy is generated in many of these projects. Modern methods for storage of perishable goods like mezzanine and rack assisted storage are becoming common. Latest models of material handling equipment are used. As space is getting costlier, vertical stores are increasing. Cold storage plants are all pre-fabricated at manufacturing facility and are transported and installed at project sites so that time and labour dependency is saved. Project completion time is reducing as technology improves.

Internet of Things (IoT) has made inroads in cold chain sector. It helps not only to keep products at the desired temperature, but to watch better the load from temperature sensors and GPS tracking to self-reporting alerts for computers and mobile devices. Patel states, “Smart refrigerated units even help monitor the location, temperature, humidity and motion of shipments in



real time. Advance tracking abilities give relevant parties advanced warning of any changes or malfunctions with the equipment. These types of notifications can help to ensure necessary maintenance is performed regularly or even secure alternate capacity before a load is compromised."

Data storage and retrieval system have improved. Automated messaging and alarm generation in control systems are being made to ensure messages are directly sent to service team in case of fault or for preventive maintenance. Automatic storage and retrieval systems are being introduced for cold storage, improving speed of delivery and also reducing the input energy. Green manufacturing technology is used for manufacture of double skin sandwich insulated panels, states C Subramaniam.

## Outlook

According to CRISIL Research, it is expected that the industry will grow 13-15 per cent in value terms annually over the next five years, riding on demand from QSR, meat, seafood, bio-pharmaceuticals, organised retail, and exotic fruits and vegetables. Multi-purpose cold storages are expected to increase their share (value terms) from 80 per cent to 87 per cent by fiscal 2023.

Investments in reefers suffer from lack of first- and last-mile connectivity. Private players are averse to investing in these because of stiff competition and reluctance of end-user industries to transport via reefers as these involve higher costs. In this context, it makes sense for a player providing both TCW and TCV services to offer an integrated package to clients willing to pay, rather than as stand-alone services. That would help to improve



**Shiv Kumar**

Country Marketing Manager  
Fujian Snowman

"Cold chain industry is undergoing consolidation and becoming organised pattern from scattered and unorganised form. In present scenario, we witness more responsible contribution, sensitivity towards environment and energy efficient solutions by stakeholders like end users, contractors, OEM and consultants."

utilisation, and thereby, drawing investments. Gandhi from CRISIL expects to see Rs 150-200 billion of investments to flow into the industry in next five years. "The demand for cold and frozen storage, cold chain and industrial refrigeration is ever increasing and this industry will grow and will last for a long time. This is the only solution for the economy to become very strong and we can increase our exports in areas where we are one of the leading producers in the world," suggests C Subramaniam from ISHRAE.

"Over the next five years the Indian cold chain market is expected to witness consolidation due to growing private investments, entry of foreign refrigeration and insulation equipment manufacturers in the country and growing demand for cold storage facilities and logistics from the pharmaceutical, ice cream, frozen food, bakery and confectionery and meat products," concludes Patel from Ice Make Refrigeration. ■

## Engineers scale up a low-cost, energy-saving cooling system

CU Boulder and University of Wyoming engineers have successfully scaled up an innovative water-cooling system capable of providing continuous day-and-night radiative cooling for structures. The advance could increase the efficiency of power generation plants in summer and lead to more efficient, environmentally-friendly temperature control for homes, businesses, utilities and industries.

The new research demonstrates how the low-cost hybrid organic-inorganic radiative cooling metamaterial, which debuted in 2017, can be scaled into a roughly 140-square-foot array—small enough to fit on most rooftops—and act as a kind of natural air conditioner with almost no consumption of electricity.

"You could place these panels on the roof of a single-family home and satisfy its cooling requirements," said Dongliang



Zhao, lead author of the study and a postdoctoral researcher in CU Boulder's Department of Mechanical Engineering.

The technology, which takes advantage of natural radiative cooling principles, is described today in the journal *Joule*. "As Earth's temperature warms due to the absorbed heat from the sunlight during the day, it continuously emits infrared light to the cold universe all the time," said Professor Ronggui Yang of Mechanical Engineering and lead author of the study. "During the night, Earth cools down due to

the emission without the sunshine."

The researchers' film-like material reflects almost all incoming sunlight while still allowing an object's stored heat to escape as much as possible, keeping it cooler than ambient air even in the midday sun. "The material, which we can now produce at low cost using the current roll-to-roll manufacturing techniques, offers significant advantages," said Associate Professor Xiaobo Yin of Mechanical Engineering and CU Boulder's Materials Science and Engineering Program. "We can now apply these materials on building roof tops, and even build large-scale water cooling systems like this one with significant advantages over the conventional air conditioning systems, which require high amounts of electricity to function," said Associate Professor Gang Tan of the University of Wyoming's Department of Civil and Architectural Engineering. ■



**“We need to work around a model which is India centric”**

Werner & Finley has been one of the leaders in offering highly energy efficient cooling systems in the market, states **Viplov J G, CEO, Werner Finley** during an e-mail interaction with **Cooling India**.

#### **Please take us through milestones of journey of the company.**

Established in 1986, Werner Finley (WF) is founded by my father, J R Gundu Rao, who is a mechanical engineer and had more than three decades of experience in the field of maintenance of machine tools and cooling systems in large public sector like BEML. WF was conceived in a very small workshop that was 100 square feet in space with 4 employees in an old Industrial area in Bangalore. The first product that was manufactured was the Panel Air conditioner, which was used to cool control panels of various machine tool. In 1994, the company was incorporated as a private limited company and during this year a new product line was introduced, which was the oil or coolant chiller that again was useful to cool and re-circulate coolant in machine tools. During this year Gundu Rao's nephew, Sharath Kumar, joined the business and started assisting in managing and growing the

organisation. Today Sharath Kumar heads Finance and corporate business.

During 1998, after completing mechanical engineering from RV College of Engineering, I joined my fathers venture and got trained in various faculties like production, design and sales until 2007. Post 2007, I was given the opportunity to lead the business as the CEO. My approach was to first build a strong team, then fill up the gaps in the product range, reach out to multiple applications in various industrial sectors, spread geographically within and outside of India. From 2007 until now, we have grown from 35 people to 160 people Strong. We have two manufacturing units in Peenya, Bangalore. We have the widest range of fluid and air cooling systems in the country. We cater to a wide array of industries, ranging from automotive, machine tool, food processing, healthcare, data centre, plastics, renewable energy, pharma, chemical, printing, etc. Our supplies have reach not only

all over India, but to neighbouring countries like Bangladesh, Srilanka, Nepal, Myanmar, Maldives and also to the continents of Europe and US.

Today Werner Finley is one among the top players in India in the space of process cooling, owing to its strong design capabilities and deep understanding of various applications and its nitty-gritties. We also have a very strong sales and service team, across the country, headed by our Sales and Marketing Director, Prashanth A N, who is a BE, MBA ... with 2 decades of experiences in sales of related solutions.

### **What are the cooling solutions offered by the company?**

We offer water chillers, starting from as low as 0.3 TR to 200 TR, oil and coolant chillers for machine tool application, panel air conditioners for control panel cooling, heat exchanger systems for solar inverter cooling application, data centre cooling systems for low and medium density rack cooling ranging from 3.5 kW to 35 kW and cold rooms for storage of perishables, like fruits, vegetables, meat, ice cream, dairy, etc.

### **What is process cooling? What are the applications of process cooling?**

There are two major verticals in cooling. One is comfort cooling and the other is process cooling. As the word suggests, comfort cooling is nothing but air conditioning for cooling spaces in which humans operate.

Process cooling is applied to manufacturing processes that produce heat and where this heat is undesired and needs to be removed. By removing this heat continuously and efficiently, the process will achieve higher safety, productivity, quality and reliability.

Like for example in a server, where data is being processed, lots of heat is produced. If this heat is not removed continuously and efficiently, the servers will malfunction and eventually stop working. Therefore, use of suitable cooling systems will allow the servers to operate in a conditioned environment, where it can operate efficiently and continuously, so that the user gets an uninterrupted experience at an optimum cost.

Applications of process cooling are in metal working, heat treatment, painting, laboratory, plastic processing, packaging, laser, food processing, brewery, winery, distillery, MRI, CT and Lineac, data centre, power electronics, printing, concrete batching, reactor jacket cooling, vacuum coating and furnaces, sugar refineries and soaps and detergents.

### **What are the technical innovations that would you like to incorporate in products to make them more energy efficient?**

The cooling system is one of the major power guzzlers in the process industry. So, being energy efficient is a must and a major differentiator. Werner Finley has been one of the leaders in offering

highly energy efficient cooling systems in the market. For example, a water chilling system was designed and installed in an IT major at Bangalore, for data centre application. It is the most energy efficient air-cooled chiller in the market, with a 0.6 IKW/TR. WF has many options like digital scroll compressors, VFD based scroll and screw compressors, EC fans, VFD pumps, Adiabatic cooling pads for air cooled condensers, electronic expansion valves. These can be plugged during the selection of the cooling system variant, which will make it highly energy efficient.

### **What's your take on the recent performance of cold chain and refrigeration industry?**

To put it simply, we cannot expect the cold chain or refrigeration industry to reflect what happened in countries like US, China, Europe, etc. These markets are different from Indian markets on many counts.

We need to work around a model which is India centric and caters to the specific demands and conditions of the Indian markets. Production in our country is highly fragmented and we have huge infrastructure issues, which need to be kept in mind while conceptualising the cold chain for India.

For example, the milk collection and distribution model in India, started by Amul, is so different from the western models. And that is why dairy is so successful in India as an industry. So, design thinking needs to be applied in cold chain, to be able to see scale in shorter periods. Otherwise, we will have to wait till things get organised, which can be too long a wait for many of us.



**we cannot expect the cold chain or refrigeration industry to reflect what happened in countries like US, China, Europe, etc. These markets are different from Indian markets on many counts.**

### **How technology is defining Indian cold chain industry's future?**

More energy efficient systems make storage less expensive. May be natural cooling and solar powered systems can be the answer. We have witnessed change in refrigerants from F gas to natural refrigerants. IoT has made the operations of cold storage more connected, efficient and sustainable.

### **How do you see the future of the industry beyond 2019?**

Markets are volatile and unpredictable. Information is available on real time basis. Competition is fierce and global.

### **Are you planning to launch any new product in near future?**

We have recently launched the data centre cooling systems range, which can be adopted for cooling low and medium density server racks. These systems are highly energy efficient, compact and IoT enabled.

# Internet of Things in HVAC

Internet of Things (IoT) is revolutionising HVAC industry in terms of energy efficiency, productivity, cost-effectiveness, and customer experience. The article gives a brief about Internet of Things (IoT) and its applications in HVAC.



Photo Credit: [www.gridpoint.com](http://www.gridpoint.com)

HVAC (Heating, Ventilation and Air-Conditioning) is the technology of indoor and automotive environmental comfort. HVAC systems use ventilation air ducts installed throughout a building to supply conditioned air to a room through outlet vents, called diffusers; and ducts to remove air through return-air grilles. HVAC System design is based on principles of thermodynamics, fluid mechanics and heat transfer. HVAC

system is important in design of medium and large offices and industrial buildings and marine environments. The three central functions of heating, ventilation and air-conditioning are interrelated, especially, installation, operation and maintenance costs. HVAC systems can provide control and automation of lighting, heating (like smart thermostat), ventilation, air conditioning systems, and appliances such as washers or dryers, ovens or

refrigerators or freezers that use Wi-Fi and the Internet for remote monitoring.

The statement that our world is becoming more inter-connected is an understatement when we consider 'The Internet of Things' (IoT). In the world of HVAC and cooling systems, it is easy to see that air conditioning systems are becoming more intelligent with a greater range of remote communication options which can lead to improvements in

operating costs and overall energy efficiency. There are also sub-categories for IoT and one of the biggest is the Industrial Internet of Things (IIoT) which has come about to support automation under Industry 4.0 (The 4th Industrial Revolution). It is also suggested that digitalization (The 4.2 Industrial Revolution) has to play a very important role in transforming Industrial Revolution in this field.

## What is IoT?

IoT (Internet of Things) is a network of physical devices with embedded electronics, software and connectivity which enables remote monitoring and data exchange via the Internet for management, control and energy saving. It is estimated that by next three years, over 30 billion devices will be connected to the IoT. The IoT will change the way HVAC systems are monitored, analysed and controlled in the years to come to increase energy efficiency and ease of maintenance in particular.

## Advantages of IoT Enabled HVAC Devices vs Traditional Systems

HVAC systems continue to evolve and one of the key developments aside from energy efficiency is in network connectivity. It is possible through Simple Network Management Protocol (SNMP) to provide an air conditioning system with an IP address and add to a local network for management and control. Simple Network Management Protocol is a set of protocols for network management and monitoring. These protocols are supported by many typical network devices such as routers, hubs, bridges, switches, servers, workstations, printers, modem racks and other network components and devices. HVAC systems can be connected to Building Management Systems (BMS) in a similar way or using more basic signal contacts. In place of fixed wire systems, remote control is possible via wireless connections to handsets and thermostats. Most systems require an additional monitoring or communications card or adapter to allow this level of communication.

IoT may enhance a new dimension with the provision to add the HVAC devices to a wider and smart building network that can

access sensors to detect the presence of occupants and personalise the heating or cooling settings of rooms they use on a regular basis to their chosen set levels. These levels influence and guide individual elements within a building's heating and cooling systems in terms of temperature levels, fan speeds, compressor speeds and air flow direction. It changes the way HVAC systems can be monitored and controlled through advanced information collection and analysis to bring advantages not just in terms of heating, ventilation, air conditioning and refrigeration but overall energy efficiency and operating cost control.

Predictive maintenance can be done if IoT connected HVAC system is installed. Connected systems are able to analyse the information they gather and actually alert managers to unusual equipment behaviour or system failure, which results in quicker response times and the ability to avoid potentially devastating problems. Additionally, internet-based systems help to reduce maintenance and repair costs over time.

IoT connected system can detect a change or issue and send a notification within minutes of the occurrence. This process allows the user to review the data and issue a diagnosis from anywhere (maybe on mobile) at any time (say over the weekend too) so, the situation can be addressed immediately, ultimately saving both time and energy costs.

## Improved Energy Efficiency & Operational Performance

Connecting HVAC to IoT provides opportunities to improve operational performance and energy efficiency by linking performance to other data sets. These could include weather forecasts, holiday periods and even local usage in smart buildings whose users are tagged to let the intelligent building system know whether they are on site or not and which rooms they are using. It is an example of a form of artificial intelligence (AI) within a smart building as the HVAC systems make real-time adjustments to optimise their performance and adjust themselves within a range of operational parameters.

The benefits to the organisation realise themselves in terms of lower energy bills and improved energy efficiency with the potential to reduce costs by around 25-30 per cent per year compared to traditional or conventional HVAC systems.

## Methods

### With a Wi-Fi Smart Thermostat

These are not expensive and are useful for many reasons. For example, a person may set his or her present thermostat at a certain temperature. Then he or she keeps running back and forth to change the setting because it doesn't maintain the temperature that he or she wants in all rooms.

Every degree inaccurate controls can account for 3 per cent of annual energy expense.

Following are some reasons to upgrade to a 'Programmable' Smart Thermostat.

- It is capable of adjusting home's temperature from any room in the house, from the office or on a trip.
- The temperature one selects is what he or she gets.
- It can save money.
- One can pre-heat or cool his or her home as he returns from a trip.
- One may receive e-mail alerts when his or her home temperatures are too high or too low.

### Cloud Based Data Availability

Some organisations are moving their data operations to cloud based data centers and maintaining local service rooms or micro-datacenters on the site. Using data centers in the cloud enable HVAC manufacturers and related installation and maintenance resellers to access data on their field populations for trend analysis from a secure storage environment. For any HVAC device connected to the IoT, the device is visible in terms of its location, operational information and service requirements.

### Real Time Monitoring & Control

It is a direct result of the Internet of Things age and this level of connectivity will increase for other devices within a building including access, security and power management. Without this type of



innovation, traditional controls remain a hindrance with increased costs and less opportunity to raise energy efficiency by maintaining a zoned-approach to heating and cooling.

## Local Management on Site

Internet enabled cooling systems with open protocols provide opportunities for app developers and their imagination and entrepreneurial drives. Applications could be created to improve local management or interface with other IoT devices on the site.

## Points to be considered about IoT at Home or Buildings

Not only homes, but businesses, restaurants have found enormous benefits with 'Smart' Wi-Fi Thermostat capabilities due to the variations in temperatures from the kitchen to the dining area, to spaces less used, or used intermittently.

Internet-based systems can be entirely controlled by users, but the coolest part is that they don't need to be. The most advanced systems have actually been designed to adapt to their surroundings like never before. With the help of smart sensors, systems can measure temperature, humidity and air flow throughout the entire building as well as determine external factors such as the weather forecast and current utility rates. With this rich information in hand, the system adjusts its settings to plan for upcoming situations, thus, boosting efficiency. By learning how to alter its behaviour based on current or upcoming factors, it is able to proactively create a comfortable environment instead of reacting to changes after they occur.

Example: Let's say a heat wave is due to hit in the area for two days. A connected system will note this temperature spike and cool one's building down overnight when it is the most cost-effective to do so to save energy costs.

HVAC buildings having smart, connected sensors track both external sources and interior performance to optimise energy efficiency.

## IoT Challenges in HVAC

IoT (also called the Internet of Everything) is essentially about connecting conventional objects and sensors to the Internet, transforming them from ordinary items into smart devices. Some examples include connected cars, thermostats, refrigerators, and televisions. While the opportunities are vast from improving manufacturing processes to more efficient response to humanitarian aid crises to more intuitive healthcare services, there are some notable IoT challenges and risks standing in the way of success.

### Cyber Security Risks

That there are some glaring security issues with the Internet of Everything. As IoT hacks involve tangible objects (rather than data alone), physical damage (e.g., a Heater being hacked and crashed) can result in addition to malware or identity theft.

### Lack of Universal Architecture

Currently, devices are not operating on a single network, which poses an issue for interoperability. For the IoT to reach to its full potential, devices need to be able to properly communicate with one another, as well as the network. Right now, some devices can connect to multiple devices, while some can connect only to manufacturer approved devices, and others still can connect only to the Internet,

not with any other devices. Designing products within a specified architecture would result in two advantages device compatibility and increased security controls.

### No Open Standards

A universal architecture is not where the need for structural development ends. Open standards are also needed for interoperability and network regulation. A degree of government involvement is necessary to develop and implement standards, much like what we saw with the involvement in the development of the Internet.

## Conclusion

Overall, the Internet of Things (IoT) will lead to many improvements in how devices are managed, the loading on national grids and their energy efficiency management. The benefits cannot, however, be made without taking care when it comes to one major area of concern which is that of cyber security.

For devices connected to the Internet even greater care must be taken in terms of providing gateway security and access to onsite networks. This will be one of the biggest concerns to organisations running one or more data centers or server rooms. For these types of facility cooling is one of their biggest costs and they stand to benefit the most from Internet of Things enabled air conditioning, cooling, refrigeration and heating system management and control and their interface with smart building technologies.

Internet of Things is shaping the way we interact with objects as well and its impact spans a wide range of business sectors. For the HVAC industry, IoT means better managed maintained, connected and efficient systems. But, it actually means more than just a connected system – it means a smarter environment engaged in constant communication. ■

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# Cooling technology for Metro Stations

A centralised chilled water plant improves the overall energy efficiency of the air-conditioning system and reduces the station footprint.



Serdica underground railway metro station

**O**ne of the challenges of air conditioning an underground metro system is to find space at the ground level to house the vent shafts for the station environmental control system (ECS) and tunnel ventilation system (TVS), cooling towers and water tank for the station cooling system, escape staircases, and station entrances. The need for cooling appliances is primarily

concern especially in hot and humid climates. Furthermore, the demand increasing exponentially as more subway systems consider adaptation measures for future rising temperatures due to global warming. In addition to the spatial requirement for the above systems, there is an expectation from the public to reduce massive structures at the ground level so as to develop pleasant aesthetic

environment for the area surrounding the station entrance.

## Introduction

The chilled water system is mostly used to provide cooling for the underground station, the following equipment is basically designed for placement at ground level: for a four-car underground railway station, it is assumed that the cooling

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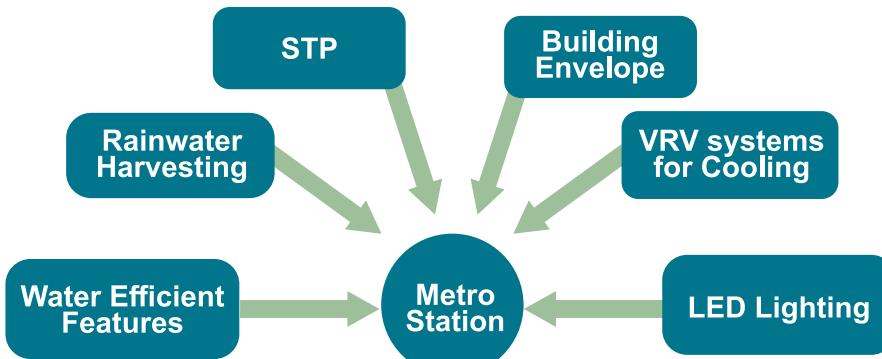


Figure 1: Key components of metro power station

tower makeup water tank is about 60 cubic metres so that it can provide 24-hour operation for the station in case of incoming water supply failure. It is located about 3 metres above the finished floor level of the cooling tower plant to facilitate the gravity feed of makeup water to the cooling towers. It occupies a footprint of 35 square metres with an effective water level at a height of about 1.7-metre. Together with the 1-metre maintenance and inspection space around the tank, the total space required for the cooling tower makeup water tank is approximately 70 sq.m. The cooling tower plant creates a bulky structure near the station entrance that has a substantial visual impact to the surrounding area.

### Centralised chilled water plant

For metro station of large capacity, it has been proposed a centralised chilled water plant concept in order to improve the overall energy efficiency of the air-conditioning system and reduce the station footprint. This concept can also improve the aesthetic ambience of the station entrances. Due to the large plant room size required to house them, the chiller plant

and cooling tower plant are the key elements (Fig.1) of effective station planning. The extent and location of the cooling tower plant also introduce a visual and aesthetic impact to the station entrance and could present a noise nuisance to the neighbourhood. In this, the centralised chilled water plant will be located at Station B with chilled water supplied to the adjacent Station A and Station C (see Fig. 2). The chilled water supply and return pipes will run along the cut and cover tunnels and bored tunnels to serve the adjacent stations.

In consideration of system reliability and additional pressure loss along the tunnels, two pairs of chilled water pipes are proposed. Under a normal situation, each pair of chilled water pipes is designed to supply 50 per cent of station load. In case the pipe work in one tunnel cannot be used, the pipe work in the non-incident tunnel can provide a total of 75 per cent of station load. This is to ensure that there is no interruption of the air-conditioning supply to the stations' critical plant rooms in the event of a tunnel fire emergency or potential mechanical damage to the pipes.

Chilled water system is used in for air

conditioning components of which are given below.

- Water cooled chiller (Screw chillers).
- Twin cell cooling towers for Condenser water piping connected with chiller for heat rejection.
- AHUs to blow air through ducts.
- Chilled water pumps and Condenser water pumps to pump water to chiller and cooling towers.

These are the major equipment used in the air conditioning in metro stations. Apart from this, two water cooled chillers are also used for the air conditioning of various other rooms like server rooms, controlling rooms and ticket office rooms.

In some cases, geothermal heat pumps are also used as shown in Fig. 3 for thermal comfort of the metro stations. That provides an excellent opportunity to use this renewable energy source in cities with densely built underground infrastructures. Geothermal energy that uses bore holes up to 400 metres in depth.

Now coming to the ventilation part, ventilation on metro stations is being provided with the help of TVS. Here, OTE dampers, which look like square cut-outs, are provided to exhaust the heat dissipated from the OHE and friction.

### Design Considerations

Having compared the system requirement of the two schemes, the advantages and disadvantages are summarised as follows:

#### Advantages

- By sharing equipment, a centralised chilled water plant requires less maintenance space to accommodate

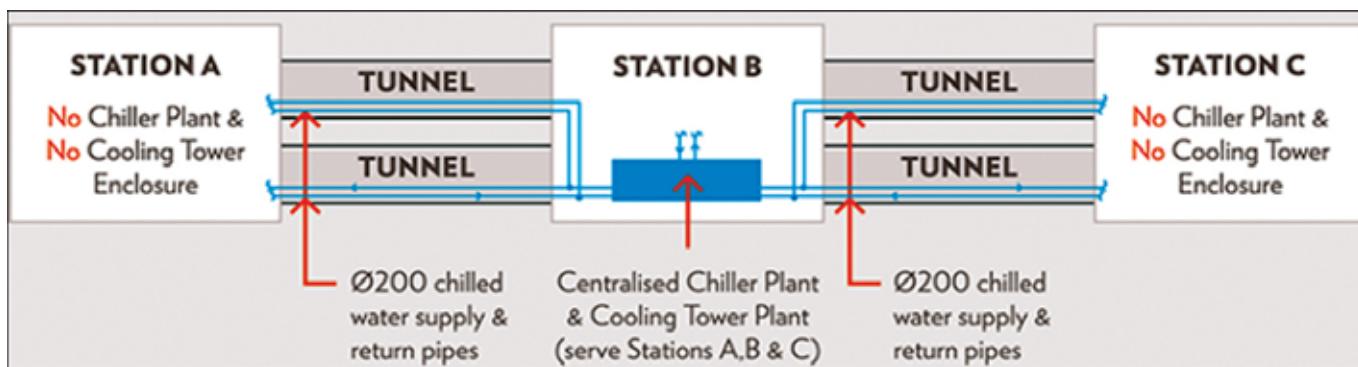


Figure 2: Details of the centralised chilled water plant

the chillers, cooling towers, and pump accessories, although the equipment will be larger.

- The use of larger chillers is more energy efficient.
- The station footprints at the adjacent stations (Station A and Station C) are reduced as underground space does not have to be allocated for the chiller plant.
- Station entrances at the adjacent stations are streamlined as it is not necessary to allocate at-grade space to house the cooling towers.
- The total amount of equipment is reduced and less maintenance work will be required.
- There is flexibility in selecting the stations along the metro lines which will have cooling towers installed.

## Disadvantages

- The station which houses the centralised cooling tower plant (Station B) will require a large at-grade footprint.
- It is necessary for two pairs of chilled water pipes to be run inside the tunnel to serve each of the adjacent stations. This requires close coordination with the electrical and mechanical services group to free up space for mounting of the chilled water pipes on the tunnel wall.
- Inspection and maintenance of the chilled water pipes inside the tunnel will be required, also possible replacement.
- As there is limited tunnel wall space at the cross-passage door location, tunnel services may be routed into the

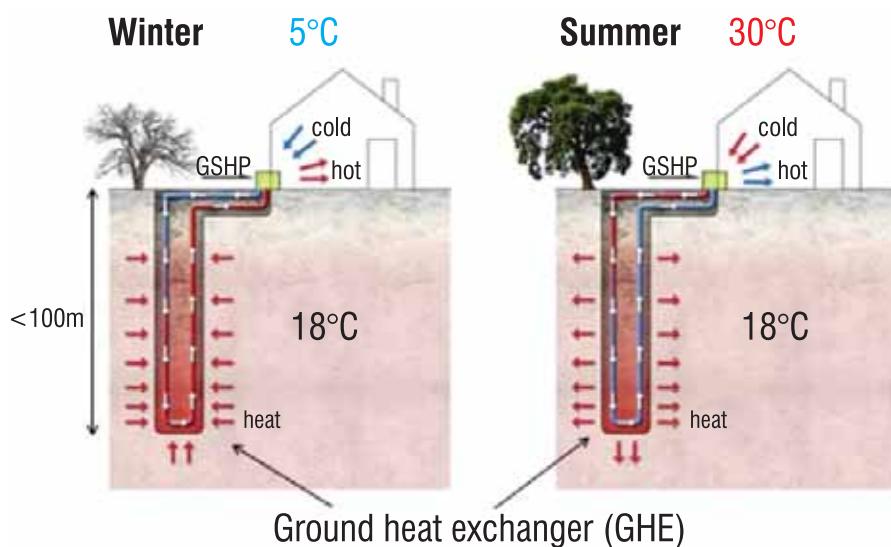


Figure 3: Metro stations with geothermal systems

cross passage as a buffer zone to facilitate services crossing the cross-passage door opening. Considering the large pipe size, chilled water pipes would be located to avoid running in the inner wall to avoid such situation.

- Due to the temperature difference between the tunnel environment and the chilled water supply/return pipe, it is necessary for the chilled water pipe to be insulated, which may impose a spatial constraint within the tunnel.
- Station chilled water pumps in the centralised chilled water plant need to be upsized to compensate for: additional pipe and fitting loss within the station with the central plant; additional pressure loss along tunnels; and pipe failure in one tunnel.

## Conclusion

The adoption of a centralised chilled

water plant concept offers benefits that outweigh the disadvantages. It achieves an overall cost savings in initial cost, operating cost, and maintenance cost and effort. The use of a larger centralised chiller will improve overall energy efficiency. And for stations with limited footprints, it eliminates the need for chiller plant and cooling tower space, thereby improving the ambience of the underground station and the station entrance. There have been concerns that future replacement of a centralised chilled water plant and the pipe works in the tunnel may affect the daily operation of the chiller plant. The implementation of a centralised chilled water plant concept has to be in the early design stages of metro station cooling projects. It will be difficult to implement the scheme once the land take is done, as large space is required for the station with the centralised chilled water plant. ■

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# Carbon Dioxide: A Natural Alternative Refrigerant

The choice of refrigerant for a particular application depends on safety, reliability, cost and performance of the overall system. Presently, more emphasis is given on the environmental aspect because of ozone layer depletion and global warming.

Photo Credit: [www.refrigerationschool.com](http://www.refrigerationschool.com)



**R**efrigerants are the working fluids used in a refrigeration system that extracts heat from a body or space and thus, producing some cooling effect. The system performance is dependent on the thermo-physical properties of refrigerants. The choice of refrigerant for a particular application depends on safety, reliability, cost and performance of the overall system. Presently, more emphasis is given on the environmental aspect because of ozone layer depletion and global warming occurring due to the uses of different refrigerants. The evolution of various refrigerants falls under different generations which are dictated by different levels of priority. Different generations of refrigerants categorised under different levels of priority have been presented in Figure 1. At the beginning of mechanical refrigeration, in the early 19th century

natural refrigerants were mainly used. Refrigerators that were built in the late 1800s to 1929 used the first-generation refrigerants such as methyl chloride, ammonia and sulphur dioxide. The common refrigerants for the first hundred years included whatever worked and whatever was available. Nearly all the first-generation refrigerants were flammable, toxic or both and some were also highly reactive. The second-generation refrigerants were distinguished by a shift to chloro-fluoro chemicals for safety and durability. The third-generation refrigerants were mostly low ozone depletion potential refrigerants. Besides having low ODP and GWP values, they can also be used in existing refrigeration system designs. Ultimately, the fourth-generation refrigeration considered all the above-mentioned factors along with high performances.

## Evolvement of CO<sub>2</sub> as Refrigerant

At the end of the nineteenth century different refrigerants began to evolve. Carbon dioxide was one among them. Carbon dioxide was first solidified in 1835 by a French physicist, Thilorier and from then it is being used as a cooling agent, popularly known as dry ice to solidify mercury. Lowe was first to suggest that carbon dioxide could be used as a refrigerant in 1867. In 1884, Raydt built a R744 (CO<sub>2</sub>) refrigeration system for making ice using a vapour compression mechanism while, at the same time, J Harrison was the first person to build a device for manufacturing R744 purely for refrigeration use. Franz Windhausen patented a refrigerating compressor machine that used carbon dioxide in 1886.

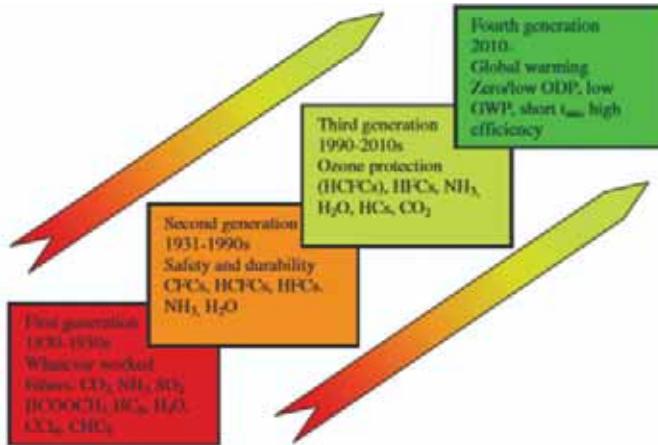


Figure 1: Different generations of refrigerants

The British Company J&E Hall built a carbon dioxide compressor taking permission from Windhausen. Later the same company built the first two-stage CO<sub>2</sub> compressor also. That was the beginning for extended use of carbon dioxide as refrigerant in refrigeration system. Later its application was enhanced in various systems as such onboard of refrigerated ships and also in other sectors of refrigeration. The use of equipment working with CO<sub>2</sub> as a refrigerant mainly involved when beer brewing and meat were started to transport from Australia and Latin America to Great Britain in 1890.

### Abandonment and Revival of CO<sub>2</sub> as Refrigerant

After the evolution of the second-generation refrigerants like

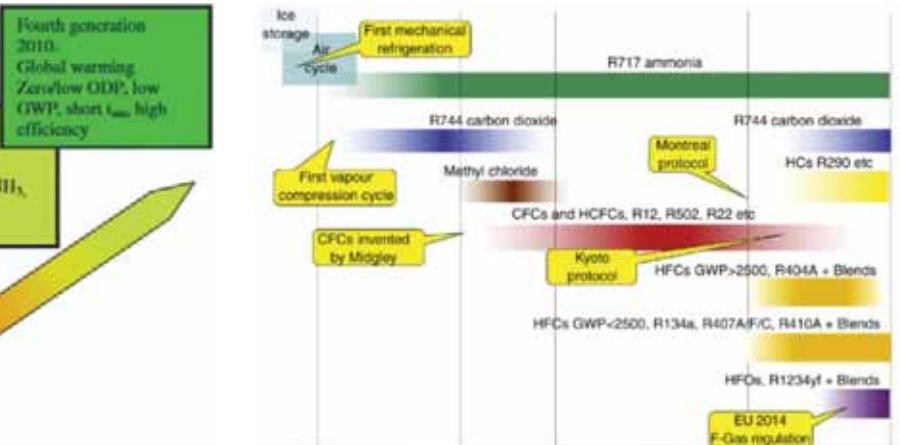


Figure 2: Timeline related to the discovery of various refrigerants and their use

chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFCs), the use of CO<sub>2</sub> was phased out eventually in most of the industries. The cause for doing so is it has got a very low critical temperature of 31.1°C which is not ideal for sub-critical operation. However, with increase in ambient temperature, the system gradually changes from sub-critical operation to trans critical operation accompanied by a high operating pressure. When the system is in trans critical operation, the expansion valve has a very large pressure drop causing a great energy loss resulting in a drop in COP. But the environmental issues associated with other thermodynamically efficient refrigerants paved the way for CO<sub>2</sub> as refrigerant. Figure 2 shows about the timeline of different refrigerants and

refrigeration systems evolved along with CO<sub>2</sub>.

Although, the use of CFCs and HCFCs were in vogue for a longer period of time, but at the end of twentieth century, it is established that these halogenated refrigerants were the root cause of stratospheric ozone layer depletion. These are eventually phased out in many countries as per recommendations of the Montreal and Kyoto protocols in 1987 and 1997 respectively. Under these circumstances, CO<sub>2</sub> has once again found its importance as an eco-friendly, safe and reliable refrigerant.

Professor Gustav Lorentzen was the pioneer of the revival of R744 refrigeration in the early 1990s. By the end of the early 1990s, CO<sub>2</sub> has earned its significance in most of the refrigeration and industrial

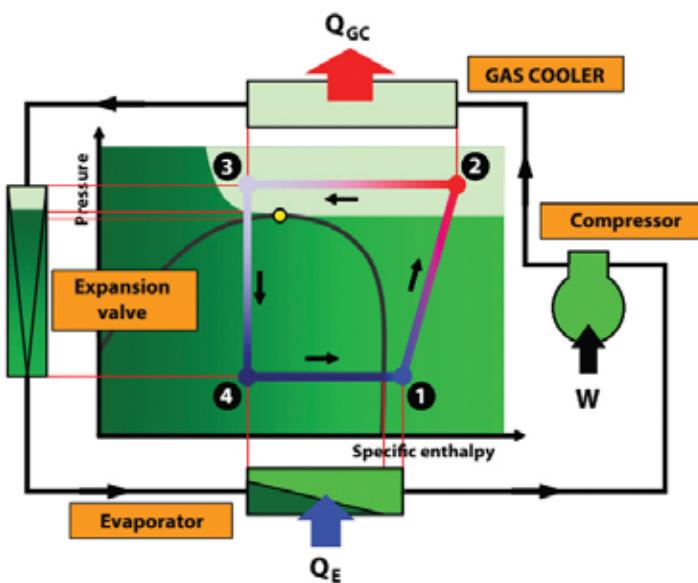
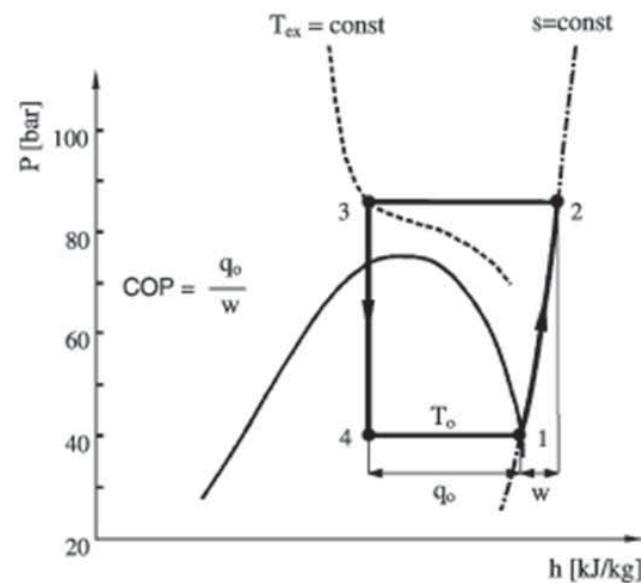
Figure 3: (a) Schematic and (b) T-s diagram of a transcritical vapour compression system using CO<sub>2</sub>

Table 1: Thermo-physical and Environmental Properties of Different Refrigerants

Refrigerant	Critical temperature (°C)	Critical pressure (MPa)	Normal boiling point (°C)	Flammability/ Toxicity	ODP	GWP
R12	100.9	40.6	-29.8	N/N	0.9	8100
R22	96.2	49.8	-40.8	N/N	0.055	1500
R32	78.4	58.3	-52	Y/N	0	650
R134a	101.1	40.7	-26.3	N/N	0	1200
R152a	113.5	45.2	-25	Y/N	0	140
R404a	72.1	37.4	-46.2	N/N	0	3300
R407c	86.8	46.0	-43.6	N/N	0	1600
R410a	72.5	49.6	-48.5	N/N	0	1900
R290	96.8	42.5	-42	Y/N	0	3
R600a	135.0	36.5	-11.7	Y/N	0	3
R717	132.2	113.5	-2.22	Y/Y	0	0
R1234yf	95	33.8	-30	N/N	0	4
R1234ze	109.4	36.36	-18.95	N/N	0	1
R744	31.0	73.8	-78.3	N/N	0	1

sectors due to its excellent thermodynamic as well as environmental properties. CO<sub>2</sub> as a natural refrigerant is mostly implemented in low temperature refrigeration systems such as in food processing industry and in supermarket refrigeration systems. This is so because at low temperatures, CO<sub>2</sub> has got many unique thermo-physical properties. Some of them are: high latent heat of vaporisation, high vapour density and low surface tension which enable the sub-critical refrigeration systems to achieve high COP. Properties of different refrigerants used in the past, being used at present and promising future refrigerants are listed in table 1 for comparison.

CO<sub>2</sub> is abundantly found in the

atmosphere mainly as derivatives of industrial waste products. It has been considered one of the ideal refrigerants in mechanical vapour compression refrigeration (VCR) systems. Presently, it has found its place in marine refrigeration and also as an alternate refrigerant to ammonia and methyl chloride due to its non-toxic nature.

## Transcritical Vapour Compression Refrigeration using CO<sub>2</sub>

Transcritical cycle is the thermodynamic cycle where the working fluid goes through both subcritical and supercritical states. As CO<sub>2</sub> has a low critical temperature (31.1°C), therefore, during operating at

high ambient temperature, vapor compression system for refrigeration will work nearly or just above the critical pressure (7.38 MPa). Heat rejection will take place mostly at supercritical and low side condition in subcritical pressure making it a transcritical system (single stage). The schematic and the P-h diagrams of a transcritical CO<sub>2</sub> vapour compression system have been shown in Figure 3(a) and Figure 3(b) respectively. It may be noted that a gas cooler is being used instead of the condenser in the transcritical system.

## Cascade Refrigeration System using CO<sub>2</sub>

The cascade refrigeration system is a

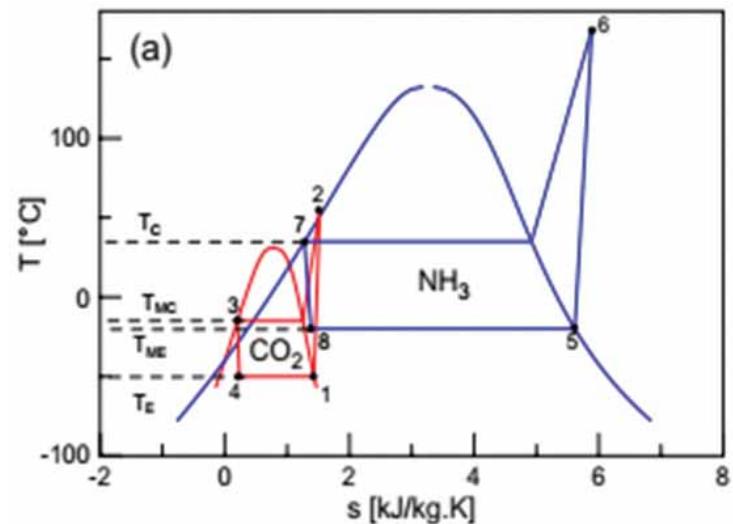
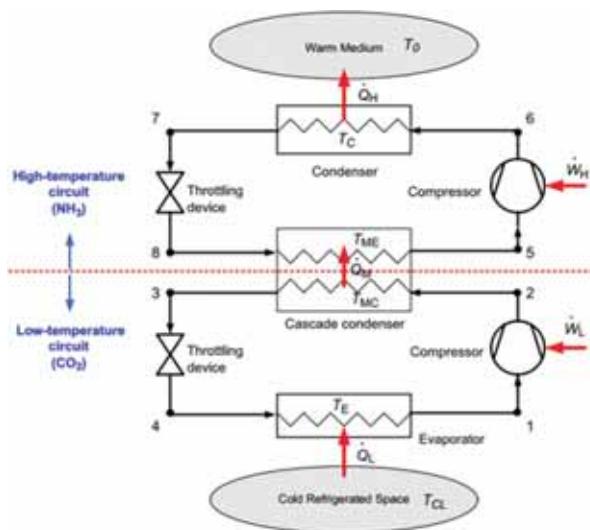


Figure 4: (a) Schematic and (b) T-s diagram of a CO<sub>2</sub>/NH<sub>3</sub> cascade refrigeration system

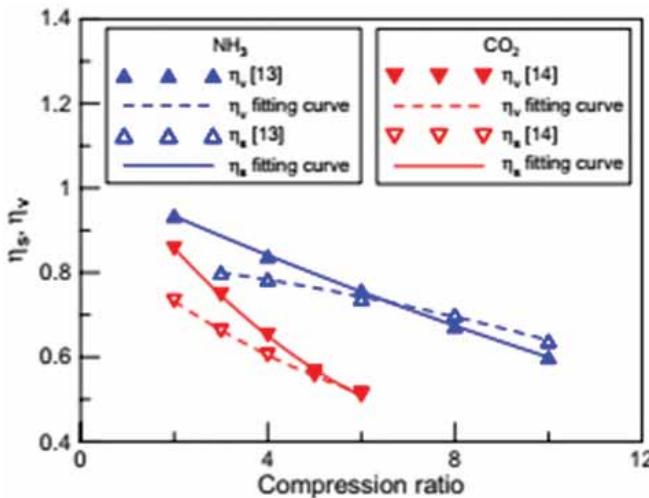


Figure 5(a): Isentropic and Volumetric efficiency vs compression ratio of CO<sub>2</sub> / NH<sub>3</sub> cascade system

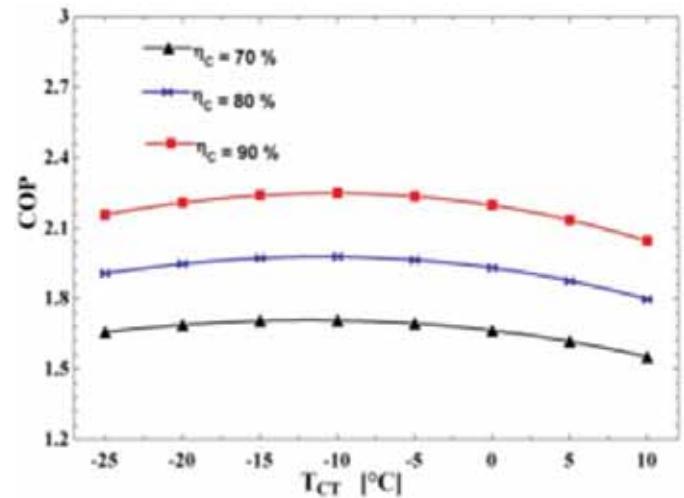


Figure 5(b): COP vs coupling temperature of CO<sub>2</sub>/NH<sub>3</sub> cascade system at different  $\eta_c$

refrigerating system that generally works with two kinds of refrigerants having different boiling points, which run through their own individual freezing cycle and are connected by a heat exchanger. Many industrial applications like food storage, liquefying of petroleum vapour and natural gases, precipitation hardening of some special alloys, dry ice production, storing of blood etc., required low temperature refrigeration in the temperature range from -30°C to -100°C. For low temperature refrigeration of that range, single stage systems become inefficient. A cascade system can be considered a suitable option for this low temperature refrigeration system if proper refrigerants are used which in turn depends upon the desired temperature required for various applications. Apart from that heat transfer characteristics, safety, environmental issues and lubricants compatibility of refrigerant pair should be considered. In the design phase for CO<sub>2</sub> cascade refrigeration system, CO<sub>2</sub> is used in low temperature circuit (LTC) and NH<sub>3</sub> (R-717) in the high temperature circuit (HTC). Two circuits are thermally joined to each other through a cascade-condenser, which acts as an evaporator for the HTC and a condenser for the LTC. The arrangement of different components of a CO<sub>2</sub>/NH<sub>3</sub> cascade refrigeration system has been shown in Figure 4(a). The corresponding T-s diagram has also been presented in Figure 4(b).

## Applications of CO<sub>2</sub> as Refrigerant

As mentioned earlier, CO<sub>2</sub> was first used as a cooling agent popularly known as dry ice that sublimes at -78.3°C. However, in refrigeration, there are enormous applications for R744, some of which have been commercialised. A few of the important application areas where CO<sub>2</sub> is used as refrigerant are discussed below:

### Water Heat Pumps

Production of hot water is the best application for R744 heat pumps as the temperature slide in the transcritical cycle suits the thermodynamic properties of water well. Very efficient heat transfer and very high-water temperatures are achieved with water heating applications using a counter-flow gas cooler. The percentage energy saving of a heat pump ( $\Delta E$ ) when compared to another heating system with an efficiency of  $\eta$  is given by:

$$\Delta E = \left( \frac{1}{\eta} - \frac{1}{\text{COP}} \right) \times 100 \quad (1)$$

For electric heaters,  $\eta$  is nearly equal to 1 and it varies from 0.5-0.95 for fuel-fired heaters.

### Mobile Air-Conditioning

Mobile air-conditioning system consumes 31 per cent of the world's refrigerant, which adds up to more than 150,000 ton/year. Compact R744 systems coupled with good heat transfer

characteristics between air and R744 encourage the use of these systems in a sector in which equipment space and weight are limited while energy efficiency is predominant. With the phasing out of HFC in progress, R744 is one of the best alternatives for mobile air conditioning. R744 air conditioning will work especially well with fuel-efficient hybrid or electrical cars with little waste heat available. With electrical cars specifically, if the air-conditioning system is efficient enough, more energy will be used to drive the car and thus more travelling distance will be covered before the electricity runs out. However, the only limitation of R744 in mobile air-conditioning applications is its high heat rejection temperature.

### Commercial Refrigeration

Commercial refrigeration consumes about 28 per cent of worldwide refrigerants. This makes it one of the largest emitters of refrigerants into the environment and accounts for approximately 37 per cent of worldwide emissions. This equipment includes refrigerated display counters in supermarkets, refrigerated vending machines, water coolers or heaters and ice generating machines. Till the year 2000, R744 applications in commercial refrigeration were not considered viable. The perception has now changed with its use either as a heat transfer fluid, in a cascade system, or on its own in either a transcritical cycle or a subcritical cycle,

depending on the environmental temperature. External factors like safety requirements, extra tax on HFC systems and limitations on the maximum amount of HFC charge that can be used on a single are the main reasons for R744 acceptability in commercial refrigeration.

## Residential Air-Conditioning

The use of CO<sub>2</sub> as refrigerant in air conditioning systems has been the focus of investigations by both research institutions and industry because of the high demand for such equipment and the requirement for HFC alternatives. The annual demand for residential air-conditioning units is more than 40 million units and further market growth is expected. Air conditioning is the second largest consumer of energy after water heating in most residential areas. Environmental concerns in this application are more focused on the indirect impacts of emissions due to energy use, than on the direct impacts of refrigerant leaking. Therefore, energy efficiency is paramount.

## Environment Control Units

Military operations usually require

space conditioning for their temporary shelters, command modules and vehicles, which should be able to withstand the unique operational environment. The compactness of R744 equipment in addition to its availability globally has led to an increased interest in R744 space-conditioning systems for the military.

## Future Applications for R744

The potential of R744 refrigeration is far wider than the applications discussed above. Experts assert that R744 as a refrigerant show promise of capturing more markets, even outside the refrigeration industry, although currently, it is the natural refrigerant with the widest range of use. Some future potential uses of R744 as a refrigerant are information technology (IT) equipment cooling, industrial heat pumps and industrial waste heat recovery.

## Conclusion

CO<sub>2</sub> commonly referred to as R744 has emerged as an excellent natural refrigerant for low temperature refrigeration applications. The use of a sub-critical refrigeration cycle for CO<sub>2</sub> at low

temperatures can greatly reduce the condensation pressure within the pressure range of standard refrigeration applications. Besides, it has also got zero ODP and very low GWP value which made its place very much stabilised in the field of refrigeration. However, due to its low critical temperature, it had been abandoned for some time and it was replaced by the second and third generation refrigerants such as the CFCs and the HCFCs.

But they were also being phased out due to their high ODP and GWP values. So, due to prior necessity CO<sub>2</sub> has been again introduced in refrigeration systems. Presently, this refrigerant is widely implemented in food processing industries and supermarket applications. Apart from these industries, CO<sub>2</sub> is also used in cascade refrigeration systems due to its non-toxic and non-flammable and odourless nature. Moreover, as compared with ammonia two-stage refrigeration system, the CO<sub>2</sub>/NH<sub>3</sub> cascade refrigeration system has a significantly lower charge amount of ammonia, and the COP of the cascade system exceeds that of a two-stage system at low temperatures. ■

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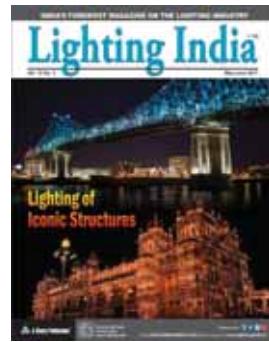
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# Design of Cold Storage for Fruits & Vegetables

The design of cold storage facilities is usually directed to provide for the storage of perishable commodities at selected temperature with consideration being given to a proper balance between initial, operating, maintenance, and depreciation costs.



Photo Credit: www.sihsonvegetable.com

**C**old storage is the one widely practiced method for bulk handling of the perishables between production and marketing processing. It is one of the methods of preserving perishable commodities in fresh and wholesome state for a longer period by controlling temperature and humidity within the storage system. Maintaining adequately low temperature is critical, as otherwise it will cause chilling injury to the produce. Also, relative humidity of the storeroom should be kept as high as 85-90 per cent for most of the perishables, below which has detrimental effect on keeping the quality of the produce.

Most fruits and vegetables have a very limited life after harvest if held at ambient

harvesting temperatures. Post-harvest cooling rapidly removes field heat, allowing longer storage periods. Proper post-harvest cooling can:

- Reduce respiratory activity and degradation by enzymes;
- Reduce internal water loss and wilting;
- Slow or inhibit the growth of decay-producing microorganisms;
- Reduce the production of the natural ripening agent, ethylene.

In addition to help maintaining quality, post-harvest cooling also provides marketing flexibility by allowing the grower to sell produce at the most appropriate time. Having cooling and storage facilities makes it unnecessary to market the produce immediately after harvest. This

can be an advantage to growers who supply restaurants and grocery stores or to small growers who want to assemble truckload lots for shipment. Post-harvest cooling is essential for delivering produce of the highest possible quality to the consumer. Cold storage can be combined with storage in an environment with addition of carbon dioxide, sulfur dioxide (in case of grapes) nitrogen, etc. according to the nature of product to be preserved. The cold storage of dried or dehydrated vegetables can be successfully carried out for a storage time of more than one year at 0°-10°C with a relative humidity of 80-95 per cent.

The cold storage of perishables has advanced noticeably in recent years,

leading to better maintenance of organoleptic qualities, reduced spoilage, and longer shelf lives. These advances have resulted from joint action by physiologists to determine the requirements of fruit and vegetables, and by refrigerating specialists to design and run refrigerating machines accordingly.

Care should be taken to store only those kinds, which does not show in compatibility of storage, when storing multi-produce in the same room. For example, apple can be stored with grapes, oranges, peaches, and plums and not with banana. However, with potato and cabbage slight danger of cross actions can occur. Contrary to this, grape is compatible to all other vegetables except cabbage. To resolve the incompatibility during cold storage, foodstuffs are grouped into three temperature ranges

Based on their thermal incompatibility the produce is classified into:

#### **Most perishable products, not sensitive to cold (0-4°C)**

e.g. Apple, grape, carrot and onion

#### **Vegetable produce moderately sensitive to cold (4-8°C)**

e.g. Mango, orange, potato and tomato (ripened)

#### **Vegetable produce sensitive to cold (>8°C)**

e.g. Pineapple, banana, pumpkin and lady finger

Based on the purpose, the present day cold stores are classified into following groups:

**Bulk cold stores:** Generally, for storage of a single commodity which mostly operates on a seasonal basis e.g.: stores for potatoes, chilies, apples etc.

**Multi-purpose cold stores:** It is designed for storage of variety of commodities, which operate practically, throughout the year.

**Small cold stores:** It is designed with pre-cooling facilities. For fresh fruits and vegetables, mainly for export-oriented items like grapes etc.

**Frozen food stores:** It is designed for with (or) without processing and freezing facilities for fish, meat, poultry, dairy products and processed fruits and

vegetables.

**Mini units or walk in cold stores:** It is located at distribution center etc.

**Controlled atmosphere (CA) stores:** It is mainly designed for certain fruits and vegetables

### **General Arrangements and Consideration**

If produce is to be stored, it is important to begin with a high quality product. The produce must not contain damaged or diseased units, and containers must be well ventilated and strong enough to withstand stacking. In general, proper storage practices include temperature control, relative humidity control, air circulation and maintenance of space between containers for adequate ventilation and avoiding incompatible product mixes. Commodities stored together should be capable of tolerating the same temperature, relative humidity and level of ethylene in the storage environment. High ethylene producers (such as ripe bananas and apples) can stimulate physiological changes in ethylene sensitive commodities (such as lettuce, cucumbers, carrots, potatoes, sweet potatoes) leading to often undesirable color, flavour and texture changes.

The general features of a cold store operational programme (products, chilling and chilled storage and freezing) include total capacity, number and size of rooms, refrigeration system, storage and handling equipment and access facilities. The relative positioning of the different parts will condition the refrigeration system chosen. The site of the cold chambers should be decided once the sizes are known, but as a general rule they should be in the shade of direct sunlight. The land area must be large enough for the store, its annexes and areas for traffic, parking and possible future enlargement. A land area about six to ten times the area of the covered surface will suffice.

There is a general trend to construct single-storey cold stores, in spite of the relatively high surface: volume ratio influencing heat losses. The single storey has many advantages: lighter construction;

span and pillar height can be increased; building on lower resistance soils is possible; internal mechanical transport is easier. Mechanical handling with forklift trucks allows the building of stores of great height, reducing the costs of construction for a given total volume.

The greater the height of the chambers the better, limited only by the mechanical means of stacking and by the mechanical resistance either of the packaging material or of the unpackaged merchandise. The length and width of the chambers are determined by the total amount of merchandise to be handled, how it is handled (rails, forklift trucks), the number of chambers and the dimensions of basic handling elements. There is no advantage in building many chambers of a small size. Thermal and hygrometric requirements are not so strict as to justify a lot of rooms: the accuracy of the measuring instruments and the regulation of conditions inside the chamber always produce higher deviations than those of ideal storage conditions for different products. This is particularly true for frozen products.

A design that opts for fewer, larger chambers represents in the first place an economy in construction costs as many divisional walls and doors are eliminated. Refrigeration and control equipment is simplified and reduced, affecting investment and running costs. Large chambers allow easier control of temperature and relative humidity and also better use of storage space. Only in very particular situations should the cold store be designed with more than five or six cold chambers. Store capacity is the total amount of produce to be stored. If the total volume of the chambers is filled, the quantity of produce by unit of volume will express storage density.

Several parameters must be defined within a cold store. The total volume is the space comprised within the floor, roof and walls of the building. The gross volume is the total volume in which produce can be stored, that is excluding other spaces not for storage. The net volume represents the space where produce is stacked, excluding those spaces occupied by pillars, coolers,

ducts, air circulation and traffic passages inside the chambers that are included in the gross volume. Storage density referred to as net volume is expressed in kg/m<sup>3</sup>. But it is most commonly referred to as gross volume. About 3.4 m<sup>3</sup> of volume is required per ton of potato to be preserved while for onions this value is about 5.7 m<sup>3</sup>/t. Thus, one can calculate the total volume of storage space as soon as the amount of storage product is known. An index of how reasonably and economically the cold store has been designed is the gross volume divided by the total volume. It must be in the range of 0.50 to 0.80. Similarly, gross volume is about 50 per cent greater than net volume, and gross area (same concept as volume) is about 25 per cent greater than net area. The extent of occupation is the ratio between the actual quantity of produce in storage at a given moment and that which can be stored. Equally the extent of utilisation is the average of the extent of occupation during a given period — usually a year, but it can also be per month.

The earlier cold storage were cubical in shape in order to minimize the surface area for a given volume, i.e.,  $a = b = H = V^{1/3}$

Where  $a$ ,  $b$ ,  $H$  and  $V$  are width, breadth, height and volume of storage space. In doing so the height of large cold storage becomes too big, causing material handling, stacking and similar other problems. A comparative study of the single and multi-storeyed cold store buildings has been made with respect to space and installation (Heinze, 1973). It has been found that the single-storeyed buildings turn out to be a better choice. However, the multi-storeyed cold storages with mechanised arrangements are preferred for the multi-variety systems, especially, in cities where the floor area is extremely expensive. Sometimes cold storage size is based on floor area, i.e., about 100 kg m<sup>2</sup>. However, there does not exist a unique specification agreed upon and used internationally. Despite lots of discussions differences on specification on the cold storages exist.

Temperature management during

storage can be aided by constructing square rather than rectangular buildings. Rectangular buildings have more wall area per square meter of storage space, so more heat is conducted across the walls, making them more expensive to cool. Temperature management can also be aided by shading buildings, painting storehouses white or silver to help reflect the sun's rays, or by using sprinkler systems on the roof of a building for evaporative cooling. Facilities located at higher altitudes can be effective, since air temperature decreases as altitude increases. Increased altitude therefore can make evaporative cooling, night cooling and radiant cooling more feasible. The air composition in the storage environment can be manipulated by increasing or decreasing the rate of ventilation (introduction of fresh air) or by using gas absorbers such as potassium permanganate or activated charcoal. Large-scale controlled or modified atmosphere storage requires complex technology and management skills; however, some simple methods are available for handling small volumes of produce.

## Heat Load Calculations

The optimal storage temperature must be continuously maintained to obtain the full benefit of cold storage. To make sure the storage room can be kept at the desired temperature, calculation of the required refrigeration capacity should be done using the most severe conditions expected during operation. These conditions include the mean maximum outside temperature, the maximum amount of produce cooled each day, and the maximum temperature of the produce to be cooled. The total amount of heat that the refrigeration system must remove from the cooling room is called the heat load. If the refrigeration system can be thought of as a heat pump, the refrigerated room can be thought of as a boat leaking in several places with an occasional wave splashing over the side. The leaks and splashes of heat entering a cooling room come from several sources:

- **Heat Conduction** - Heat entering

through the insulated walls, ceiling, and floor;

- **Field Heat** - Heat extracted from the produce as it cools to the storage temperature;
- **Heat of Respiration** - Heat generated by the produce as a natural by-product of its respiration;
- **Service Load** - Heat from lights, equipment, people, and warm, moist air entering through cracks or through the door when opened.

## Fundamentals for Designing a Cold Storage Project

The design of cold storage facilities is usually directed to provide for the storage of perishable commodities at selected temperature with consideration being given to a proper balance between initial, operating, maintenance, and depreciation costs. The basic procedures for constructing (or) implementing the cold store units have the following requirements:

## Process Layout

The most important requirement for any food project using insulated envelopes is to determine the process layout of the operation which is to be housed by the envelope. In the case of a meat plant, this can be a carcass dressing line or a boning room, or for a cold store, the pallet layout and mode of operation must be established. It is simply no good building an envelope and then attempting to place the processing machinery inside it.

## Planning Drawings and Application

It is only after concluding the process layout that a planning application can be made when the dimensions of the envelope and supporting buildings can be frozen.

## Design Drawings and Specifications

Once planning approval has been obtained then the preparation of design drawings and specifications can proceed. For a competitive design and construct tender, it is essential to prepare some 15 - 20 detailed drawings covering, at the minimum, the process layout, elevations

and sections, the refrigeration system layout, mechanical and electrical systems reticulation and the lighting layout.

In addition to make up package at least six separate detailed specifications are required covering the project's requirements on:

- Contractual requirements
- Building specification
- Refrigeration specification
- Insulation panel supply and erection
- Electrical requirements
- Mechanical services.

The location chosen for the cooling facility should reflect its primary function. If the plan is to conduct retail sales of fresh produce from the facility, it should be located with easy access to public roads. A retail sales operation located away from the road, particularly behind dwellings or other buildings, discourages many customers. Adequate parking for customers and employees, if any, must be provided.

If, however, the primary function of the cooling facility is to cool and assemble wholesale lots, ease of public access is less important. In this case, the best location may be adjacent to the packing or grading room. In addition to housing grading and packing equipment, the space

could be used to store empty containers and other equipment and supplies when it is not needed for cooling. All cooling and packing facilities should have convenient access to fields or orchards to reduce the time from harvest to the start of cooling.

Regardless of how it is used, the facility will need access to electrical power and water. For larger cooling rooms requiring more than about 10 tons of refrigeration in a single unit, access to three-phase power will be necessary. The location of existing utility lines should be carefully considered, as connection costs can be prohibitive in some rural areas. Consult local power company for details.

In addition, it is a good idea to anticipate any future growth when locating and designing your facility. The cold storage unit should be built on a site, a where the ground is clean, well drained and preferably leveled and near to supplies of energy and water. If possible, it should be in the shade of prevailing wind and

direct sunlight. A refrigerated store, with one (or) more thermally insulated places, and refrigerating machines can be planned with the aim of assuring certain services.

The details about :

1. Nature of the products
2. Frequency of loading and unloading
3. Calendar for harvest and dispatch
4. Field heat of the produce
5. Daily tonnage of produce to be handled
6. Daily tonnage of ice to be manufactured
7. Nature and dimension of packages

The above particulars are to be collected before initiating the cold storage unit work. The conditions to be considered for planning, a cold storage are temperature and duration of storage, handling and stacking method, type of; commodities to be stored together, prevailing climatic factors like temperature, relative humidity, rainfall, wind and water. Availability of skilled and unskilled labor from the local area is the major factor to be considered for the successful operation. ■

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## India Cold Chain in Mumbai on 13-15 Dec

Over 200 national and international exhibitors will display their products and solutions covering cold storage infrastructure, refrigeration, material handling, AIDC, cold transport and cold logistics at the show.

**I**ndia Cold Chain Show 2018 returns with its seventh edition which is scheduled to take place on the 13-14-15 of December at Hall Number 4, Bombay Exhibition Centre, Mumbai, Maharashtra.

The show has grown over the years to be the largest and leading event showcasing entire range of solutions and services for cold storage infrastructure, material handling, AIDC solutions, refrigeration, temperature control, cold transport, cold logistics and supply chain for diverse industries with cold chain intensive business operations such as dairy, ice cream, seafood, meat, frozen food, fruits and vegetables, retail, export import, logistics, oils, bakery, quick service restaurants, ports and airports, hotel, floriculture and many more.

The exhibition serves as a networking and business development platform where trade buyers or visitor industries are introduced to new technologies and innovations, leading brands and a wide variety of solutions to help build a better cold chain system (Cold Storage + Refrigeration + Cold Transport). The concurrent conference serves as a knowledge sharing and networking platform where we look to facilitate the learning of industry trends, challenges and opportunities associated within different industries.

Leading associations such as Federation of Cold Storage Association of India, National Horticulture Board, Grape Growers Association of India, Vegetables Grower Association of India, Orange Grower Association of India, Gujarat Cold Storage Association, Madhya Pradesh Cold Storage Association, Maha Cold Storage Association, Association of Cold Storage - Tamil Nadu, Sea Food Exporters Association of India, Director of Horticulture, All India Transporters Welfare Association (AITWA), Maharashtra Heavy Vehicle & Interstate Container Operator Association (MHVICOA), Bombay Goods Transports Association, Association of Ammonia Refrigeration, Mahagrapes Growers Exporters, Confederation of Indian Horticulture, Federation Of Cold Storage Association of India, Asia Pacific Logistics Federation, SCLG have confirmed their support for the show this year.

2018 edition of the show is supported by some eminent names in the industry such as Gandhi Automations as Gold Partner, Kelley Material Handling Equipment India as Silver Partner, Zirkel Infracia as Silver Partner, Emerson Climate

Technologies India as Bronze Partner, Tecumseh Products India as Registration Partner, Pluss Advanced Technologies as Conference Partner, Shakti Hormann as Lanyard Partner, Natural Storage Solutions as Turnkey Solution Partner, Icon Freshtop Private Limited as Visitor Badges Partner, The Cold Box as Presenting Partner.

### A glimpse of what India Cold Chain Show 2018 will offer:

- Over 200 national and international exhibitors will display their products and solutions covering cold storage infrastructure, refrigeration, material handling, AIDC, cold transport and cold logistics at the show.
- Over 82 first time exhibitors will be displaying their latest solutions for building an effective cold chain management.
- Over 45 new product launches from leading companies such as Gandhi Automations, Ice Make Refrigeration, Kaveri sales, Blue Cold Refrigeration, Middleby Celfrost, Pluss Advance Technology, Natural Storage Solutions, TESSOL, Shakti Hormann, Zirkel Infracia India, Air-conditioning Spare Centre, EBM Papst and many more.
- More than 120 live demonstration by exhibitors covering cold chain solutions including cold storage, frozen fulfilment, refrigerated transportation, temperature-controlled logistics and much more.
- Packaging Zone: Companies providing Cold Chain packaging and labelling solutions for pharma, food and allied industries have an exclusive area earmarked for showcasing their solutions at this edition of the India Cold Chain Show.
- Two Industry specific conferences scheduled for the 13th of December- Food Cold Chain Conference and 14th of December – Pharma Cold Chain Conference at the Bombay Exhibition Centre, Goregaon (E), Mumbai. The conference serves as networking platform to meet the leaders from the industry and understand the latest trends, opportunities and challenges via panel discussions, case studies and keynote presentations.
- Industry related Workshops will also be conducted parallel to the conference and exhibition on niche topics to help facilitate learning and application within the Cold Chain industry. ■



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# High-Speed Freezer Duo Doors from Gandhi Automations



Prime Clean Reset

The only struggle a cold storage facility faces is to maintain the desired temperature to preserve their valuable material for long. Cold storage facilities, thus, is always in search for a high-performance freezer door which helps them minimise convection and energy loss which occurs from operations of the high-speed freezer door.

High-Speed Freezer Duo doors curated by Gandhi Automations are sturdy, dependable and an ideal fit for maintaining temperature control. To prevent ice formation during intensive cooling Gandhi Automations' high-speed freezer duo doors have a functionality of partial and full opening. Its intelligent dual curtain technology - simultaneous open and close operation has blower or dryer to maintain temperature balance. They are made of Galvanised steel



guides with heating elements to reduce convection; stainless and aluminum guides are also available on request.

The high operating speed combined with an excellent seal optimises the internal traffic flow and provide energy savings. Heavy-duty motor of 400 V three phase, opening speed up to 2.5 m/s with inverter system. Suitable for both positive and negative temperature, operating temperature range +5°C to -35°C. High-Speed Freezer Duo Doors have special double curtain construction with space in-between.

They are self-repairing so its curtain resets in case it comes out of the guide due to an accident or when force opened by a forklift. If impacted, the curtain will release from the side guide and automatically reset on the next door cycle as there are no metal parts within the curtain design. The doors are manufactured with European collaboration and technology with innovative and creative engineering.

Gandhi Automations High-Speed Freezer Duo not only helps maintain temperature but also in human safety. High-Speed Freezer Doors have a revolutionary soft bottom edge and sensor combine to ensure operator safety at all times.



Prime Freezer

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## CAREL demonstrates high efficiency at Chillventa



CAREL at CHILLVENTA

**C**AREL, a multinational specialising in control solutions for the air-conditioning, refrigeration and air humidification sectors, presented its latest developments regarding user experience and connectivity at Chillventa. An upgraded offering of high-efficiency solutions that uses DC inverter technology to provide efficient solutions with low GWP and natural refrigerants for all climates, and applications of all sizes.

### Connectivity in the system and Cloud services

At Chillventa, held between 16 and 18 October, CAREL demonstrated a complete solution to guarantee management and transfer of information. Starting from the controller, the unit's brain that defines its operation, CAREL exhibited new product ranges with integrated connectivity.

At a system level, the 'boss' range has been extended with the introduction of boss mini, the local supervisory solution for managing, monitoring and optimising sites such as convenience stores, cold stores, service stations and small commercial

buildings. The boss range provides complete monitoring of the site, and automatically implements different functions for reducing energy consumption.

The offering of Cloud-based services varies according to the application and connectivity architecture. RemotePRO can centralise all the information from individual local supervisors to provide global control of all connected systems. Armilla is the web portal that optimises marketing analysis and technical maintenance for beverage coolers. tERA is the platform for creating a centralised remote management system for both individual units and small HVAC/R systems.

### APPLICA & CONTROLLA for a new user experience

APPLICA is the mobile service app developed as part of CAREL's broader unit digitisation project, with the aim of facilitating both installation and maintenance. It allows users to interact with units via a simple and intuitive graphic interface. With APPLICA, the unit can be configured in one single operation, exchanging

information with a remote service and receiving alerts in the event of alarms. APPLICA can be used to manage MPXone, the new CAREL controller retail refrigeration units,  $\mu$ CHILLER, the solution for the complete control of chillers and heat pumps, and Heez, the solution for refrigerated merchandisers.

Expanding its app portfolio, at Chillventa CAREL launched CONTROLLA, the new unit control app dedicated to end users. CONTROLLA stands out for its extensive usability, simplifying the operation of efficient and high-performance systems and allowing the unit's owner to have the system remote control in their pocket at all times. Graphic flexibility and usability are the main features that distinguish CONTROLLA.

## Natural and low-GWP refrigerants, efficiency in all climates

Chillventa 2018 saw the preview of a complete solution for residential heat pumps compatible with natural refrigerants. This is a ready-to-use system whose strengths are easy installation and completeness, in full compliance with the latest regulations and demands for natural and low-GWP refrigerants.

Also made its exhibition debut at Chillventa was Sistema DC Cella for developing CO<sub>2</sub> systems for cold rooms based on DC inverter technology, minimising installation times and complexity.

CAREL also exhibited a vast range of controllers at Chillventa: With the addition of pR multi DC, multiple DC compressors can be managed in parallel on the same line, reaching new levels of energy efficiency in transcritical CO<sub>2</sub> compressor racks. For the commercial refrigeration, Heos sistema, the renowned high efficiency water loop solution, is now available for propane, CO<sub>2</sub> and HFOs. Hecu sistema, the high-efficiency solution for



CAREL Application

condensing units, is on show in the version compatible with natural refrigerants.

## DC inverter technology

At Chillventa, CAREL presented all the benefits of DC inverter technology: complete and integrated solutions, a full package comprising HW, SW and application knowledge to facilitate end users in expanding their offering to include natural refrigerants.

CAREL can provide complete solutions that include the DC compressor, inverter, electronic expansion valve and electronic controller, in a ready-to-use system that features advanced control algorithms. Ease-of-use, safety and immediacy are the main features of CAREL's solutions, designed and built to exploit very efficient technology in the simplest way, in a growing number of applications. ■

For more info, visit [www.carel.com](http://www.carel.com)

## Thermax Closed Loop Cooling Tower

**W**ith an immense expertise in heat and mass transfer for over five decades, Thermax has been expanding its footprint across industries globally providing energy and environment solutions. As an integral part of Thermax family, the Process Cooling division offers various industrial cooling equipment to cool, reject heat, or maintain temperature during manufacturing across different industries.

The product range for process cooling includes various wet and dry cooling solutions using air, water or a combination of both as method of heat rejection. Amongst the wet cooling solutions, the most preferred option for optimising energy savings for industrial cooling is Thermax Closed Loop Cooling Tower. Thermax Closed Loop Cooling Tower provides process fluid cooling solution that comes in a sturdy structural material with long service life and requires effortless maintenance.



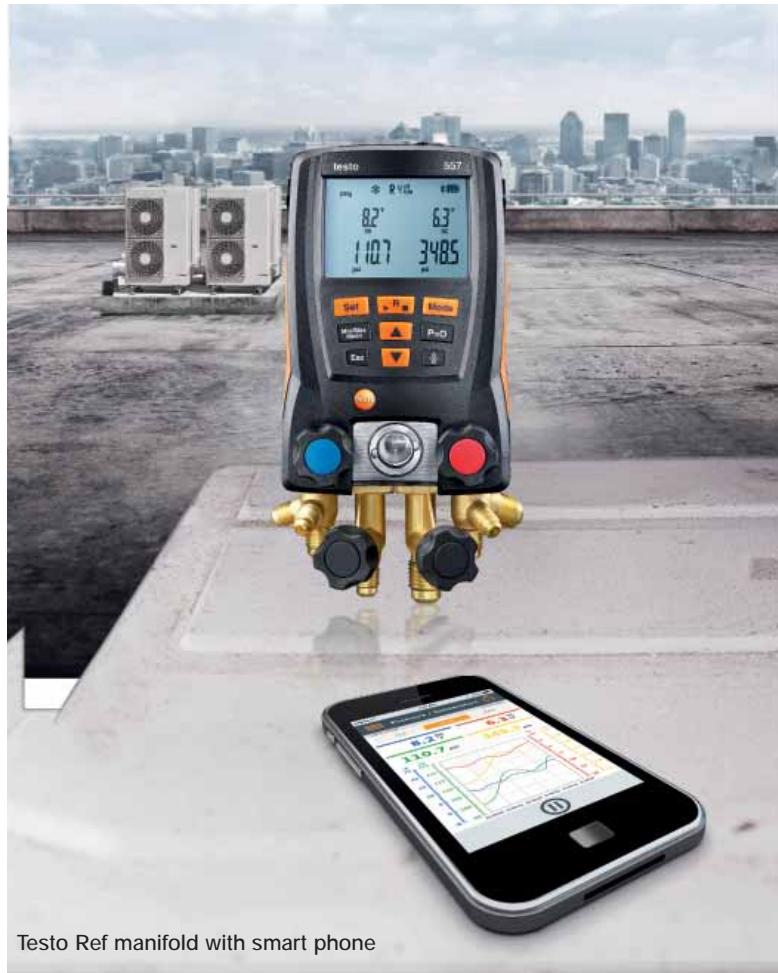
Rest assured of zero contamination due to closed loop continuous coil that quarantines the process fluid. The coil comes in HDG or SS option for corrosion-resistant optimal performance. Thermax Closed Loop Cooling Tower is a right fit for water or chemical or pulp or any other process fluid cooling and offers unmatched flexibility for various process requirements and climatic conditions, utilising mixed flow configuration.

It comes in a compact size and the modular construction allows for plug and play installation. Thermax Closed Loop Cooling Tower can be operated for higher temperature difference ( $\Delta T$ ) which makes it ideal for industries and applications ranging from automobile, chemical, power, plastic and polyfilm, pharmaceutical, steel, food and beverage, tyre, rubber to refinery.

For more info, Visit: [www.thermaxglobal.com/process-cooling](http://www.thermaxglobal.com/process-cooling)

## Smart World of Testo

Testo has introduced the technological leap in refrigeration industry with its new smart manifolds which works through an app on Smartphones or tablets making every day refrigeration tasks easier.



Testo Ref manifold with smart phone

### Digitisation- The Breakthrough

Digitisation is the new buzz in the market. Every industry has moved or is gradually moving towards digitisation from analog systems to keep the pace with the modern trade. Worldwide, the refrigeration industry is growing in a very big way in terms of warehousing, large buildings, malls, residential cooling and many more.

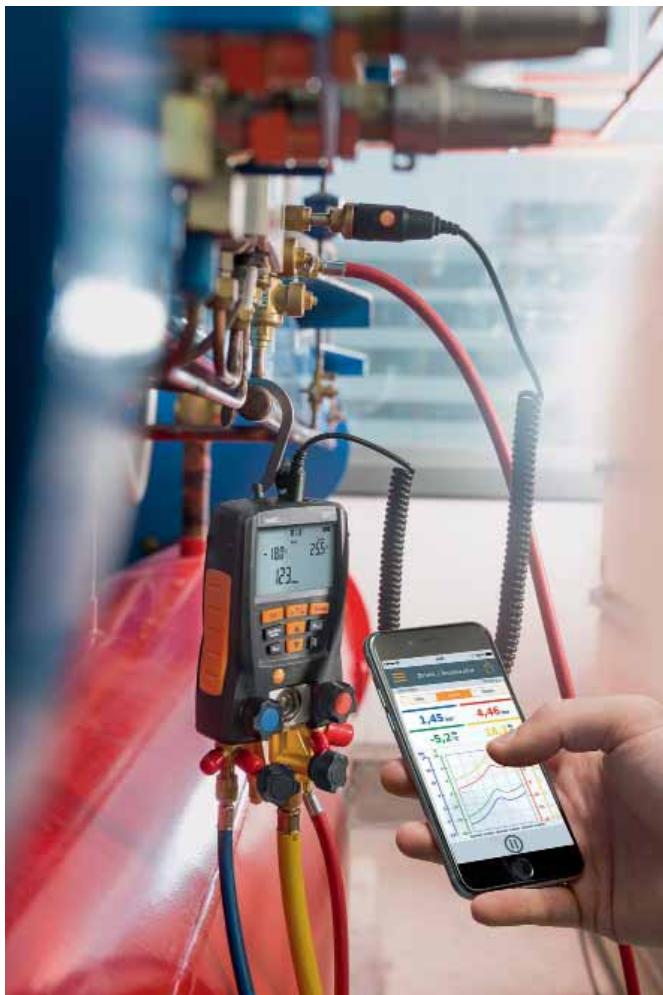
Apparently, industrial digitisation has also now started approaching the next level which is the blend of smart technology and digital processes to become not only digital but "smart". And to infuse this concept of smart technology, the refrigeration industry is all geared up to welcome the smart processes and equipment to serve faster and better than ever before.

While talking about the refrigeration industry, digital manifolds are the most obvious part of the sector that grabs the attention. Thus, being the world leader in measurement technology, Testo has introduced the technological leap in refrigeration industry with its new smart manifolds which works through an app on Smartphones or tablets making every day refrigeration tasks easier. Smartphone operation allows a client to manage everything at fingertips with the most comfortable gadget that he or she deals within everyday life.

### Smart Technology - New Transition

This change from analog to smart measuring technology is particularly worthwhile for the refrigeration industry because many different parameters, such as pressures and temperatures, along with the superheating and sub-cooling of the system, have to be checked here. An analog manifold is not really much help with this, as it can actually only determine high and low pressure. For every other task, one needs additional instruments and accordingly more expenditure, quite apart from the laborious handling and the frequent inaccuracies of measurement.

In contrast, digital manifolds with App control such as the testo 550 or the testo 557 save all other additional instruments and turn smartphone or tablet into an efficient all-round tool instead. These instruments are perfect for the complete servicing of heat pumps, air conditioning and refrigeration systems. The digital manifold kits testo 550 and testo 557 stand out, thanks to



Testo 557 application

two clamp probes, a vacuum probe (testo 557 only), the robust case, and above all the respective filling hose set. Linked by Bluetooth to the testo refrigeration App, the manifolds now make work even easier. This means one can for example measure pressure and temperature values quickly and easily, or carry out a temperature - compensated tightness test, and read out the measuring values conveniently on the smartphone, irrespective of the measuring location. System parameters such as sub-cooling and superheating can be monitored from up to 20 meters via a smartphone or tablet.

Where data have until now still been analysed by printing out the measurement protocol and laboriously saved on the PC, all measurement results can now be graphically displayed and immediately dispatched on site by e-mail - whether to the office or to the customer. And one can also update and extend the list of the most common refrigerants stored on the instrument at any time via the App. That sounds like a contemporary way of working, doesn't it?

As a habit to strive for more, Testo has also launched the smart measuring instruments (known as smart probes) in addition to the Smart manifolds.

The professional and compact testo 549i high-pressure measuring instrument can be controlled via the testo Smart



Testo 115i refrigeration app

Probes App using smartphone or tablet and is ideal for carrying out servicing and troubleshooting on air conditioning and refrigeration systems. The App also enables evaporation and condensation temperatures to be calculated automatically. Testo offers greater mobility when measuring and it is used in conjunction with smartphone or tablet, the handy testo 549i high-pressure measuring instrument is suitable for carrying out wireless servicing and troubleshooting on air conditioning and refrigeration systems as well as for installing them. The measuring instrument can be set up quickly and easily, directly at the pressure connection. The testo 549i makes working on widely spaced pressure connections considerably easier thanks to wireless connection to a smartphone or tablet. Also, it is practical as no hoses are required for measurements, meaning that no or only very little refrigerant is lost. When used in conjunction with the testo 115i clamp thermometer, individual refrigeration system parameters can also be calculated. Combined with a smartphone or tablet, the testo 115i clamp thermometer is the ideal temperature measuring instrument for carrying out servicing and troubleshooting on air conditioning and refrigeration systems, as well as for installing them. It can also be used to measure flow and return temperatures.

Professional measuring technology is now mobile: when it comes to temperature measurements at widely spaced measuring points in particular, the testo 115i makes things much easier – thanks to a wireless connection to the smartphone or tablet. When used in conjunction with the testo 549i pressure measuring instrument, individual refrigeration system parameters can also be calculated.

Refrigeration system maintenance is becoming almost as easy as writing WhatsApp messages, thanks to Testo's smart measuring technology. Because App-controlled manifolds make additional measuring instruments superfluous, streamline entire work process and save a lot of efforts as well as loads of valuable time.

For more info: Write to [info@testo.in](mailto:info@testo.in) or visit [www.testo.com](http://www.testo.com)

## Ensavior Energy & Environment Saviour

**E**nsavior Technologies Pvt Ltd is a leading comprehensive engineering solutions provider company engaged in design, engineering, sales, marketing, operation and maintenance of various products and systems for building services industry pertaining to the field of Heating, Ventilation and Air conditioning (HVAC).

The products and services promoted by Ensavior revolves around the fundamental of saving energy and environment (Ensavior - Energy & Environment Savior) with an emphasis on economic, environmental and social sustainability.

Today, Ensavior has grown to encompass several product lines serving the building services industry that includes pumps for HVAC, plumbing, fire, air purification system with a focus on Ultra Violet Germicidal Irradiation (UVGI) System, Automatic Balancing and PICV Valves, Thermal Energy Storage System, HVAC Sensors and transducers and Electrostatic precipitation system.

Ensavior has highly competent, passionate and experienced team of professionals that are energised by the company's values and ethos and are the ambassadors for a culture that aims to think better, advise better, engage with clients better and deliver better.

Through a commitment to excellence in quality, engineering and service, Ensavior has established enduring relationships with the major contractors and corporate entities, proudly contributing to the creation of airports, office complexes, IT parks, trade centres, metro rails, shopping malls, hospitals, five-star hotels, schools and manufacturing facilities throughout the Indian sub-continent.

Ensavior engages on the project right from the conceptualisation stage and thereby, help in right selection, optimum design and implementation of most energy efficient products. Besides that, the company ensures on site job trainings to project managers, facility managers and operators so that the systems are operated in most efficient and simplest manner. Based on need of the project, it also undertakes operation and maintenance of the system for which the company has back up of spare parts and manpower.

Ensavior views every project as a fresh opportunity for

continuous improvement. This results in maximum cost effectiveness, efficiency, and productivity for its customers. Realising the rapid pace of new innovative product solutions reaching the marketplace, and ever changing National Code revisions and requirements, it takes pride in educating and training of its staff to offer customers the latest in safety, convenience, and improvements.

Ensavior firmly believes that, if more you engage with customers, the things become clearer, and it is easier to co-relate to their requirements. The company has a well-established track record and its services have always met with great customer satisfaction.

It is its constant endeavour to make every aspect of the customer requirement a little bit better, since the company knows when a customer comes first, the customer lasts.....

### Partners

Strategic tie ups with Xylem Water Solutions, FlowCon International – Denmark, FTENE – Korea, Greystone – Canada, Aeropure and ESPAIR form a good mix of products that cater to the need of the hour.

### Products

- Pumping Systems : Pumps for HVAC, Plumbing, Fire
- UVGI System : Ultra Violet Germicidal Irradiation System
- Hydronic Balancing : Automatic Balancing and PICV Valves
- TES System : Thermal Energy Storage System
- ESP System : Electrostatic Precipitation System
- Sensors : HVAC Sensors and Transducers

**Pumping Systems:** The company represents Xylem water solutions for pumping solutions, which are constantly developing and fielding new HVAC systems that work efficiently, making buildings more comfortable, productive and healthy. It provides energy efficient pumps, boosters, circulators, controls, expansion tanks, air separators and other products and systems for buildings.

**Hydronic Balancing:** It is the process of optimising the distribution of water in a building's heating or cooling system so it provides the intended indoor climate at optimum energy

efficiency and minimal operating cost. The company has joined hands with Flowcon International, Denmark to provide the most efficient and most reliable hydronic balancing system.

**Thermal Energy Storage System:** Ensavor has a strategic tie up with FTENE, Korea for stratified thermal energy storage. It helps lower operational costs by enabling the shifting of energy consumption of chillers from high cost hours to low cost hours by utilising stored energy during high cost periods and storing cooling energy by running the chiller during low cost hours. Further, as lower capacity chillers may be used, the chiller can run at optimal capacity, thereby, raising its efficiency level. TES system can also be designed for emergency back-up requirements of mission critical facilities viz. Data centres, defence facilities etc.

**UVGI System:** It leads to electrical energy savings to the tune of 10 to 15 per cent by improving heat transfer efficiency of AHU cooling coil, which in turn results in reduction of chilled water requirement from the chiller. UVGI systems irradiate the AHU coils with UV-C rays, destroying the ability of the organisms to reproduce and multiply thus, maintaining the indoor air quality of the air-conditioned spaces. The company represents Aeropure for this system who are a leading manufacturer of UV lamp systems.

**HVAC Sensors and Transducers:** Ensavor represents Greystone Energy Systems, Canada for a wide range of products for sensing, measurement and transmittal of data related to temperature, humidity, pressure, current, air quality, and hazardous gases. Greystone is internationally recognised as one of the largest manufacturers of HVAC sensors and transducers for building automation management systems.

**Electrostatic Precipitation System:** ESPAIR has developed the most sophisticated and state-of-the-art technology based on Electrostatic Precipitation for commercial kitchen for filtration and elimination of pollutants like mist, dust, smoke, fumes, microbes, etc. to ensure environment-friendly, healthy and wholesome surroundings. ■

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## Forthcoming Events At A Glance

### Refcold India 2018

**Venue:** Mahatma Mandir Convention Cum Exhibition Centre, Gandhinagar, Gujarat  
**Date:** 22<sup>th</sup> to 24<sup>th</sup> November 2018  
**Website:** [www.refcoldindia.com](http://www.refcoldindia.com)

### India Cold Chain Show 2018

**Venue:** Bombay Exhibition Centre, Goregaon, Mumbai  
**Date:** 13<sup>th</sup> to 15<sup>th</sup> December 2018  
**Website:** [www.indiacoldchainshow.com](http://www.indiacoldchainshow.com)

### DairyTech Pune 2019

**Venue:** H A Exhibition Ground, Pimpri, Pune  
**Date:** 22<sup>nd</sup> to 24<sup>th</sup> February 2018  
**Website:** [www.dairyttechpune.com](http://www.dairyttechpune.com)

### ACREX India 2019

**Venue:** Bombay Exhibition Centre, Goregaon, Mumbai  
**Date:** 28<sup>th</sup> February to 2<sup>nd</sup> March 2019  
**Website:** [www.acrex.in](http://www.acrex.in)

## BCA Launches New Energy Rating for Non-Residential Buildings

Solar shades, natural ventilation and renewable energy panels are some of the prospective energy-saving features the national regulator wants to see in more Singapore buildings.

To intensify the move to a greener future, the Building and Construction Authority (BCA) has launched a new energy rating for buildings that are at least 60 per cent more energy efficient compared with 2005 building codes. Under the new rating, called Green Mark for Super Low Energy, office buildings cannot use more than 100-kilowatt hour (kwh) per square metre a year.

To help more buildings qualify for the voluntary rating, the BCA is working with industry



professionals, including property developers, to build such super low energy buildings, said its chief executive, Hugh Lim. "By setting such new performance benchmarks, Singapore can play an important role in mitigating climate change," Lim said. Previously, the highest class under the Green Mark - the BCA's benchmarking scheme - was the Green Mark Platinum, awarded to buildings that save at least half of the energy listed in the 2005 building codes. More than 10 organisations including Defence Science and Technology Agency, Singapore Management University and City Developments, have pledged to achieve at least one super low energy project in the next five years, a BCA spokesman said. ■

## Willis Tower Receives LEED Certification for Sustainability Achievements

Willis Tower, owned and managed by EQ Office owned by Blackstone's real estate funds, has earned the Leadership in Energy and Environmental Design (LEED) Gold from the US Green Building Council. Willis Tower achieved an initial LEED v2009 certification as well as the recertification tasks using the latest update to the rating system, LEED v4.1, which emphasises performance and tracks progress through the Arc platform.

Willis Tower is currently undergoing a more than half a billion-dollar renovation, the biggest restorative transformation in the building's 43-year history, adding 300,000 square feet of



new retail, dining and entertainment space, including Catalog, a five-story immersive neighborhood experience, as well as 125,000 square feet of tenant exclusive amenities and a 30,000 square-foot outdoor deck and garden to the building. "Willis Tower is a major destination in the heart of Chicago, and for more than 15,000 people, it is also their workplace," said David Moore, Senior Vice President and Portfolio Director, EQ Office. "As we redevelop this Tower, we are making a conscious effort to find ways to improve energy efficiency and reduce our environmental footprint. Earning the LEED Gold certification is a credit to our entire team." ■

## Wellington's Aurora Centre is NZ's Most Smart Buildings

The Aurora Centre in Wellington has joined an exclusive club - it's one of the most energy-smart commercial buildings in the country. Owned by retail and office building owner Kiwi Property, it has 5.5 NABERSNZ energy efficiency rating.

The building occupied by the Ministry of Social Development has recently earned the 5.5 score after a large construction and refurbishment project. The other two buildings are Aorangi House in Wellington and IAG building in Christchurch. The only higher scoring building for energy efficiency in New Zealand is 33 Customhouse Quay in Wellington, owned by Stride Property, which has a 6 rating.

The Aurora Centre rating is for the base building which includes the common areas, the lifts, the air-conditioning and small power loads of the tenant. Kiwi Property national facilities manager Jason Happy said the NABERSNZ rating validated the



company's investment and work in upgrading and refurbishing The Aurora Centre which started in 2016. The NABERSNZ rating tool has scores from zero to 6, with zero very poor performance to 4 which is excellent, 5 market-leading and 6 is aspirational. ■

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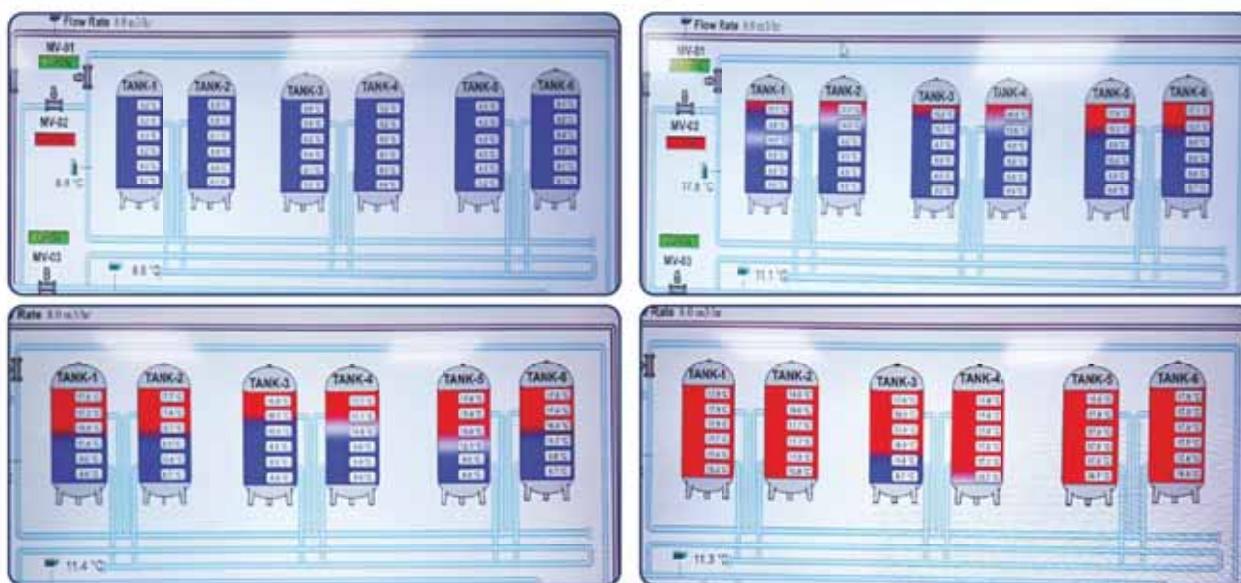
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