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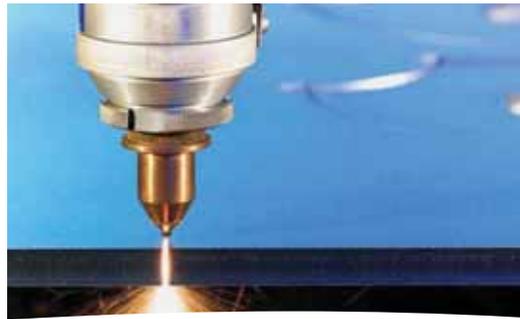


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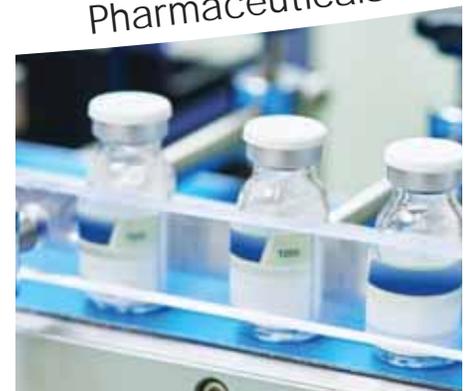
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# Publisher's Letter

Hello and welcome once again to *Cooling India*.

India is one of the fastest growing economies in the world. According to the International Monetary Fund (IMF), Indian economy is expected to grow at about 7.4% during 2019-20, thanks to the revival from the shocks of demonetisation, implementation of goods and services tax (GST), and improving investment climate. Further, as per the World Economic Forum, India's middle-class doubled in size from 300 million in 2004 to 600 million in 2012. This economic prosperity is playing a transformative role in modernising the Indian lifestyle. The HVAC&R industry is reaping significant benefits from this transformation.

The use of air conditioning in India is expected to increase by three times by the year 2030. The increase in industrialisation and urbanisation is primarily driving the demand. The focus on improving cold chain logistics and setting up of data centres is also contributing to the growth. However, the government's recent push on localising manufacturing in the form of 'Make in India' initiative has set the ball rolling.

After a huge success in REFCOLD India 2018 (Gandhinagar), *Cooling India* is all set to engage visitors at India Cold Chain Show 2018 to be held in Mumbai. A big thank you to all who participated in making these issues successful.

January marks the start of a new year and the opportunity for new beginnings and opportunities. January also marks a milestone on the *Cooling India*'s journey towards empowering the HVAC&R industry. The magazine will be coming up with its much-awaited Annual Issue in January featuring the advances, ideas, and innovations that are driving HVAC&R industry's future. We would like to invite you to voice your opinions on this sector.

Again, at the forthcoming international trade fair ACREX India 2019, scheduled to be held in Mumbai between 28th February and 2nd March 2019, your most sought-after magazine on HVAC&R industry will make its grand presence. A special issue featuring the products and technologies being showcased at the event, will be a ready-reckoner for ACREX visitors. We are looking forward to your participation in making this issue successful.

For more details write to me at [pravita@charypublications.in](mailto:pravita@charypublications.in).

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## ACCA Welcomes Honeywell Refrigerants as Partner

The Air Conditioning Contractors of America (ACCA) announces that global refrigerant manufacturer, Honeywell Refrigerants, joined ACCA's Corporate Partner program. ACCA's corporate membership program enables HVACR industry suppliers and manufacturers to demonstrate extraordinary commitment to ACCA members through year-round support of the association's activities. The corporate membership program provides financial and programming resources to ACCA, enabling the association to expand advocacy and business development activities for contractors throughout the year. "ACCA welcomes Honeywell's commitment to the contracting industry by supporting ACCA's Corporate Partner program," said Barton James, ACCA Interim President and CEO. "ACCA's mission is to provide technical training and business resources that support contractor excellence. ACCA is excited that Honeywell is committed to these programs."

Honeywell's Refrigerants business is a recognised leading innovator in the development of fluorocarbons for use as refrigerants that meet or exceed regulatory requirements. For decades, Honeywell has invented, manufactured, and sold refrigerants under the Genetron (HFC) and Solstice (HFO) brand names that demonstrate superior performance, are cost-effective to implement, safe to use, and better for the environment. "Honeywell Refrigerants is excited to join ACCA and we value having a direct connection to the nation's best contractors," said Christopher LaPietra, Vice President and General Manager of Honeywell Refrigerants. "We are committed to working with the contracting industry to ensure that contractors are prepared for upcoming refrigerant changes as well as other issues. Our partnership is important and we're committed to working closely and understanding how we can contribute." ■

## Mitsubishi Electric Trane Releases kumo cloud Skill for Amazon Alexa

Mitsubishi Electric Trane HVAC US (METUS) announces kumo cloud app integration with Amazon Alexa. kumo cloud mobile app and web service put enhanced control of heating and cooling at users' fingertips, no matter where they are. The integration with Alexa allows homeowners to enable and control their Mitsubishi Electric system simply by asking Alexa. To begin, homeowners must download the Alexa app and enable the kumo cloud smart home skill within the app. Once linked to the homeowner's account, the app allows users to turn their system on or off, change set points or modes for an individual zone or entire group, as well as request zone status, including the humidity or current temperature simply by asking Alexa or using the app.

Once the skill is enabled, homeowners can use voice prompts such as, "Alexa, what is the temperature in the bedroom," to check the room's current temperature. Customers also have the option to rename

zones to 'kitchen,' or 'girl's room' for added customisation. "We are excited to announce kumo cloud app integration with Alexa," says Charles Miltiades, Director of Controls Products & Solutions for Mitsubishi Electric Trane HVAC US. "The integration maximises smart home technology to help homeowners easily control room temperatures for optimal comfort." kumo cloud mobile app and web service provide an easy way to optimise home comfort levels – such as turning off heating and cooling systems in unused rooms or setting individual temperature preferences. The app provides remote access to the heating and cooling system in three easy steps – plug in, setup and download app. It has the capability to control various functions of Mitsubishi Electric systems, including heating and cooling schedules, system alerts, fan speed, vane direction and more. The kumo cloud app is compatible with the latest generation of Mitsubishi Electric residential HVAC systems. ■

## Carrier Helps IKEA LIVAT Centre Wuhan to Improve IAQ

While reducing outdoor air pollution has long been at the forefront in China, improving indoor air quality is now garnering more attention. To help improve its indoor air quality, LIVAT Centre Wuhan, which is affiliated with IKEA Group, selected Carrier China to provide a robust set of solutions including new air conditioning units, airside equipment cleaning and renovation, as well as chiller maintenance that helped to create a cleaner and healthier indoor shopping environment.

LIVAT Centre Wuhan turned to Carrier for solutions to address indoor air quality related to fine particulate matter, inhalable particles with diameters of 2.5 micrometers or smaller (PM2.5). After proper assessment, Carrier replaced G4 primary efficiency filters and F9 medium efficiency filters, which improved the efficiency of the air conditioning systems by 50 per cent to 70 per cent. And according to the collected statistics, Carrier managed to sharply



reduce the index of indoor PM2.5 to an excellent level of 10 to 30  $\mu\text{g}/\text{m}^3$ , while the outdoor density of PM2.5 was as high as 195  $\mu\text{g}/\text{m}^3$ , at a severe pollution level. "Over three years, Carrier has worked side by side with LIVAT Centre Wuhan to help create an improved indoor environment. The airside renovation project demonstrates the customer's trust in Carrier and our innovative solutions. We hope that this project success will shed a light on the importance of making improvements to the built environment and prompt more building owners and operators to optimise the indoor air quality," said Yin Hui, Regional Manager of Service in Wuhan, Carrier China. ■



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## Delta Cargo Introduces CSafe RAP Container



Delta Cargo is now introducing the new CSafe RAP container to its cold-chain pharma program. This high-performing temperature-controlled air cargo container is ideal for pharmaceutical companies requiring strict temperature regulations to protect its contents from operational and weather challenges during shipments to patients around the world.

“Delta is focused on driving innovation not only within the company but also within the industry. The introduction of the CSafe RAP container is a win for our customers who can now choose from the most technologically advanced containers to safely transport sensitive Pharma freight,” explained Shawn Cole, Delta’s Vice President-Cargo. The CSafe RAP container has significant advantages for shippers as it utilises innovative heating and compressor-driven cooling technologies along with superior insulation. The large payload compartment easily accommodates up to four standard US pallets or five standard Euro pallets, and the container has an extended battery run time of over 120 hours. Jeff Pepperworth, CEO of CSafe Global, added, “We have gained flight approval for our CSafe RAP active container. With Delta’s extensive global network and first-rate cold-chain pharma program, along with the superior quality and performance of the CSafe RAP, pharma shippers will have a potent combination to effectively transport temperature-sensitive, life-enhancing medicines to needing patients throughout the world.” ■

## Arnprior Regional Health Uses Energy Savings to Improve Patient Care

Preventing infections and ensuring patient comfort are priorities to healthcare organisations like Arnprior Regional Health (ARH). ARH, which includes Arnprior & District Memorial Hospital, The Grove Nursing Home and a primary care center, recently overhauled its indoor comfort system to improve temperature control and air quality, creating even more comfort for patients.

The solution reduced ARH’s energy, water and operations and maintenance costs by about USD 176,000 per year, a 28-per cent reduction in energy usage. These savings helped to offset the cost of the project. To achieve these financial and energy savings, ARH collaborated with Trane, a global provider of indoor comfort and energy services solutions and a brand of Ingersoll Rand.

“Heating and ventilation are critically tied to the environment and operations of a healthcare facility,” said John Gruno,

ARH’s Manager of Environmental and Facility Services. “In addition to comfort, the HVAC system maintains proper conditions required to operate and conduct medical procedures. The improvements will help support our ability to provide high-quality care to the communities we serve and continue our virtually non-existent rates of hospital-acquired infections.” At hospitals like Arnprior’s, reliable boilers are a necessity to maintain operations. The team created a separate mechanical room so that the existing boilers could stay functional and keep the hospital running as new ones were installed. The new boilers are much more efficient, operating at 90 per cent efficiency, versus the 67 per cent of the old boilers.

ARH is also making additional improvements to save energy and fund more equipment updates. The healthcare organisation is now working with Trane on the next phase, which includes centralised cooling for part of the facilities. ■

## Siemens Compressors Selected for ADNOC Refining in UAE

Siemens was recently selected to provide 19 process reciprocating compressors for ADNOC Refining’s crude flexibility project at Ruwais Refinery-West. The project is intended to increase the refinery’s crude processing flexibility, enabling the site to process up to 420,000 barrels of oil per day of the local crude grade known as Upper Zakum, which is found offshore. The upgrade will improve the value of each barrel of oil and allow ADNOC to export more of its main onshore, lighter-grade Murban crude.

Project commissioning is expected in 2022. Siemens will provide two 2HSE-2 net-gas reciprocating compressors; two 2HHE-VG-1 reciprocating compressors; three 2HSE-1 NL hydrogen-recycle reciprocating compressors; four 4HHE-VB off-gas reciprocating compressors; and eight 4BDC-18H3 make-up hydrogen reciprocating compressors. These API 618 process reciprocating compressors are known for their rugged design, high reliability and flexible operating range. The



compressors are supplemented with a pipeline cylinder design that incorporates the company’s legacy know-how with the latest advances in design practices, materials, valves, and capacity control.

Siemens’ Dresser-Rand process reciprocating compressors are available with up to 10 crank throws, as single-throw or balanced-opposed configurations. “Our design flexibility, ability to supply everything from a single source, advanced compressor technology, and competitive pricing were critical to being selected for this mega-project,” said Executive Vice President New Equipment Solutions and Corporate Account Management for Siemens Oil and Gas, Matthew Chinn. ■

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## UTC Completes Acquisition of Rockwell Collins

United Technologies Corporation announced the completion of its acquisition of Rockwell Collins and the company's intention to separate its commercial businesses, Otis and Carrier (formerly CCS), into independent entities. The separation will result in three global, industry-leading companies. United Technologies, comprised of Collins Aerospace Systems and Pratt & Whitney, will be the preeminent systems supplier to the aerospace and defense industry; Collins Aerospace was formed through the combination of UTC Aerospace Systems and Rockwell Collins; Otis, the world's leading manufacturer of elevators, escalators and moving walkways; and Carrier, a global provider of HVAC, refrigeration, building automation, fire safety and security products with leadership positions across its portfolio.

"Our decision to separate United Technologies is a pivotal moment in our history and will best position each independent company to drive sustained growth, lead its industry in innovation and customer focus, and maximise value creation," said United Technologies Chairman and Chief Executive Officer Gregory Hayes. "Our products make modern life possible for billions of people. I'm confident that each company will continue our proud history of performance, excellence and innovation while building an even brighter future. As standalone companies, United Technologies, Otis and Carrier will be ready to solve our customers' biggest challenges, provide rewarding career opportunities, and contribute positively to communities around the world." ■

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## Automated Logic Wins 2018 AHR Expo Innovation Award

Automated Logic (ALC) has announced that its new OptiFlex virtual integrator won the AHR Expo Innovation award in the building automation category from the American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE). ALC will receive the award during the 2019 AHR Expo in Atlanta, Georgia in January 2019. The OptiFlex will also be in the running for 'Product of the Year,' which will be announced during the awards ceremony. Each year, products in 10 different categories are recognised for being some of the heating, ventilating, air conditioning and refrigeration (HVACR) industry's most innovative products. Winners were selected based on their innovative design, creativity, value, application and segment impact.

The OptiFlex virtual integrator is a software-based integration platform for data monitoring across diverse building systems. It is a scalable integration solution, ideal for large projects such as data centers, hospitals and college campuses. The virtual integrator supports upto 50,000 data points from a single computer server, eliminating the need for multiple hardware gateways, which often require costly materials and labor, and have installation limitations due to space constraints in the most mechanical rooms. It supports BACnet IP and Modbus TCP/IP, the two most commonly used IP-based protocols as well as a new pluggable protocol technology that allows additional protocol additions. Customers can also add additional points as needed through a scalable licensing mechanism. ■

## Sofrigam Acquires Coldway

Sofrigam, the French company specialising in the cold chain for pharmaceutical products on an international scale, is pursuing its policy of further growth by acquiring Coldway, a French concern that manufactures standalone refrigeration solutions.

Coldway's innovative technology makes it possible to produce either cold or hot conditions on the basis of an elementary thermochemical reaction between ammonia and salts. Using a natural coolant that does not adversely affect the ozone layer, without consumables, but also, more importantly, without the continuous use of external energy sources, it is capable of creating cold conditions in a totally self-contained manner for up to 60 hours. With neither a motor nor a compressor, the system is silent, ecologically sound, low-maintenance and is not subject to wear.

Sofrigam became acquainted with this technology when the two companies collaborated in 2016 in order to develop a range of temperature-controlled shipping



containers featuring the Coldway technology. Coldway was placed into receivership at the end of June 2018. By virtue of this acquisition, Sofrigam is demonstrating its dynamism and its new ambitions.

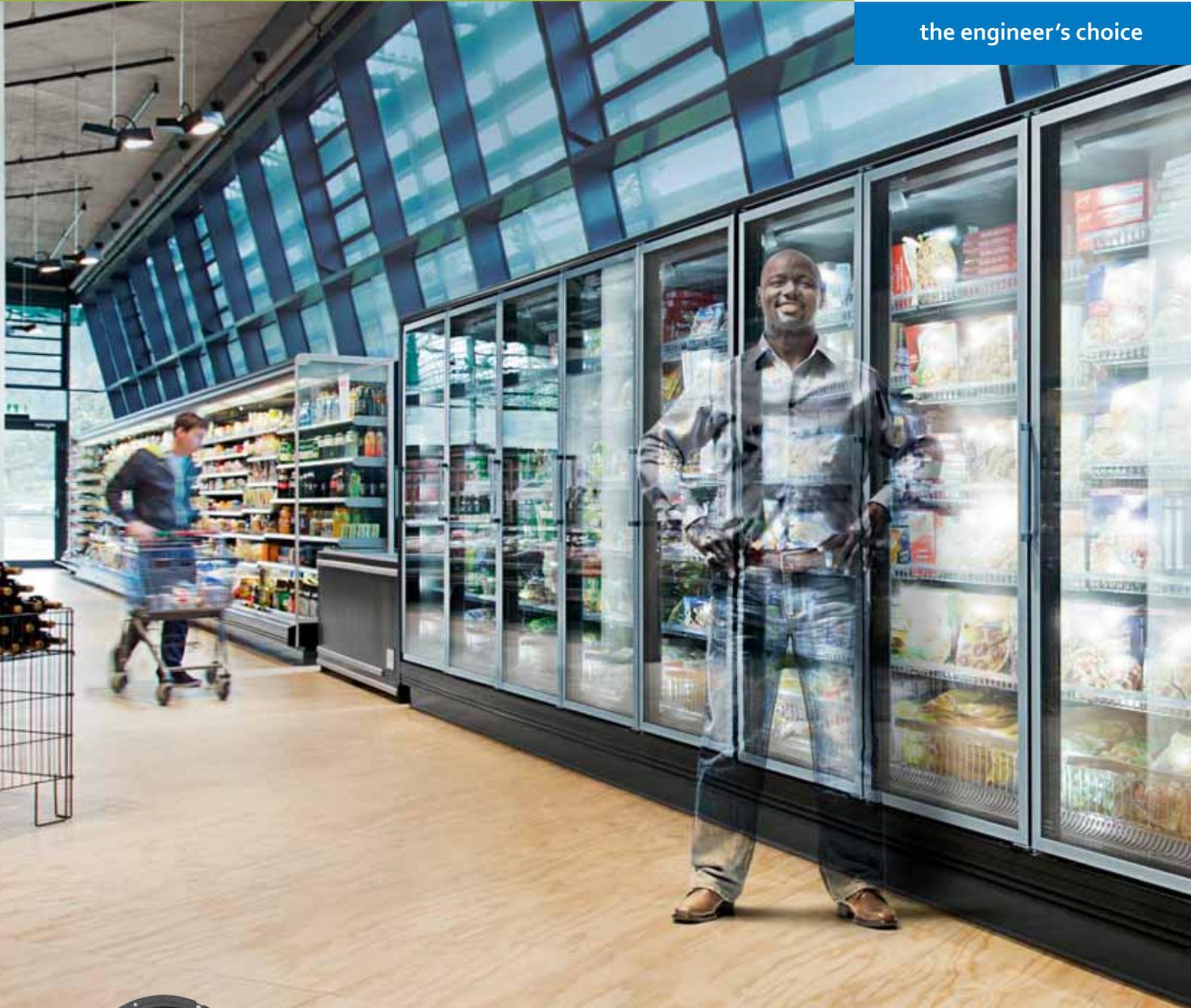
Coldway's technology will provide technical prowess and innovation for use in Sofrigam's range of packaging solutions with the ecological dimension so favoured by Sofrigam. The sixteen Coldway staff employed at Pia (66) are keeping their jobs with the company, located near Perpignan. They are joining the staff of the various entities of the Sofrigam Group, including fifteen employees in France, distributed between the head office at Rueil Malmaison (92) and the production plant, covering 16,000m<sup>2</sup>, at Monchy-le-Preux (62), near Arras. ■

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## Carel Group Acquires Entire Share Capital of Recuperator SpA

**C**arel Industries SpA announced that the acquisition of the entire share capital of Recuperator SpA, an Italian company active in the design, production and consumption of air-to-air heat exchangers has been completed.

The operation is related to the implementation of one of the main pillars of the group's strategy, which envisages targeted growth through M&A activities, also through complementary products in reference applications, in order to strengthen its core business.

Integration with Recuperator SpA in fact, will expand the product portfolio on offer in the HVAC market, consolidating CAREL's role as a supplier of complete solutions to manufacturers of air handling units, providing them with ever better solutions in terms of performance and energy efficiency. The combination of the technology used by the company involved in the transaction with CAREL's technology and its widespread sales network will help strengthen the group's European leadership in its market niches and to achieve major technological and commercial synergies. Furthermore, the regulatory context in which the operation has been completed is particularly important and favourable. Indeed, EU Regulation no 1253/2014 (so-called Ecodesign) provides for the mandatory presence of a heat exchanger for some categories of non-residential air handling units.

Francesco Nalini, Chief Executive Officer of the Group, said, "The transaction completed today is an expression of a particularly important strategic direction, that of growth through M&A, to which CAREL is paying and will continue to pay particular attention over the coming quarters. The integration with dynamic, cutting edge and complementary companies with respect to our business will be an accelerator of development that will be accompanied by organic growth, the latter based on the characteristics that have always distinguished us: innovation, energy efficiency and customer care." ■

## Daikin Announces €881m Purchase of AHT Cooling Systems

**J**apan's Daikin Industries has confirmed the acquisition of the Austrian commercial refrigeration company AHT Cooling Systems for €881m (JPY114.5bn). With headquarters in Rottenmann in the Austrian Alps, AHT is one of Europe's manufacturers of plug-in supermarket refrigerators and freezers.

Daikin will obtain all company shares from UK investment company Bridgepoint. Completion of the acquisition is planned for January 2019. AHT employs around 1600 people and achieved revenues of €481m in 2017. Daikin says the purchase of AHT will enable it to be able to "propose total systems that cover the entire cold chain. With this acquisition, Daikin is adding AHT showcases to its own wide range of products, services, and solutions

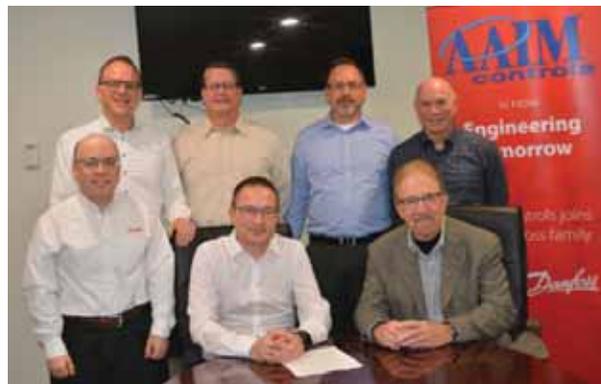


based on its air conditioning and refrigeration equipment. This will enable the company to become a one-stop provider offering complete coordination of air conditioning and refrigeration products. This acquisition is also expected to solidify Daikin's business foundation in Europe and promote full-scale expansion of its refrigeration business in the United States as well as Asia." ■

## Danfoss Acquires US-based Industrial Refrigeration Technology Leader

**D**anfoss announced the acquisition of AAIM Controls, located in Waynesboro, Pennsylvania, US. As a leader in the North American industrial refrigeration market, AAIM Controls is a specialised supplier of custom-designed regulation and control automation solutions, from motor starters to complete PLC systems. With the acquisition, Danfoss moves to a strong and unique position as a systems provider within industrial refrigeration.

Jürgen Fischer, President of Danfoss Cooling, said, "We consistently look to strengthen our core businesses by partnering with other successful companies and acquiring technology that complements the solutions we offer to our customers. By adding electronic regulation and control automation to our already-extensive portfolio of components for industrial refrigeration applications, we strengthen our global position by becoming a systems provider in the industrial refrigeration market."



With global megatrends like digitalisation and combatting climate change driving the industrial refrigeration market forward, the demand is increasing for bundled solutions of products, as well as intelligent control and automation, that increase energy efficiency, ensure food safety, and help in the transition to alternative, climate-friendly refrigerants.

"In the industrial refrigeration market, controllers are often seen as the central part of a system offering. With the addition of AAIM's strong knowledge base and their highly specialised solutions, we gain a unique competitive advantage where we can better address these customer requirements," said Kristian Strand, President – refrigeration and A/C controls, Danfoss Cooling. ■

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## University of Birmingham Appoints Indian Cold Chain Expert

The University of Birmingham has appointed leading Indian sustainable cold chain expert Pawanexh Kohli as an honorary professor for post-harvest logistics. As CEO of India's National Centre for Cold Chain Development (NCCD) Professor Kohli has played a key role in shaping policy and projects aimed at solving post-harvest food loss, particularly, in developing refrigeration networks linking the farmers to market. The Birmingham Energy Institute has made the high profile appointment in recognition of Professor Kohli's leadership in sustainable food logistics in meeting key development targets and his role in helping define the applied research programs between Birmingham and India to deliver the radical innovation needed.

Professor Kohli has a long relationship with the University. In 2015, the Birmingham Policy Commission on Cold Chain chaired by Lord Teverson recognised Kohli's contributions as an expert witness. Professor Martin Freer, Director of the Birmingham Energy Institute, said, "Prime Minister Narendra Modi has set India the challenge of doubling farmers' income by 2022. The cold chain is a key part of a solution to boost India's food security and reduce environmental impact. "Pawanexh Kohli has worked closely with government and industry to help define Indian policy in this area; a key figure in this critical field of developing expertise. He has been invaluable in helping the University of Birmingham effectively design its work in this field with Indian partners."

In 2012 Professor Kohli helped to establish the NCCD which works between the Government of India, farmers and industry. He acts as Chief Advisor to the Department of



Pawanexh Kohli

Agriculture and Farmers' Welfare on post-harvest management, cold chain and supply chain. He is also an expert member on the Empowered Steering Committee for the implementation of the Montreal Protocol in India. Under his leadership NCCD has produced over 30 reports and policy pieces which have set the agenda for the Government of India in this area. They have also helped deliver one of the first cold chains from the north to south of India.

Professor Pawanexh Kohli said, "I am personally surprised and most honoured. I am sure this will embolden many other cold-chain stakeholders to do so much more. The University of Birmingham has clearly taken the lead in affirming that post-harvest logistics is the backbone to sustaining the agricultural system, worldwide. Effective post-harvest logistics makes agriculture more environmentally and economically relevant." The appointment follows a recent event in India, which saw the University welcoming environmentalists and industrialists to explore ways of advancing the use of clean cold technology to meet in a sustainable way the rising demand for cooling. The event followed an agreement signed this year by the University and the State Government of Haryana to develop centres of excellence for clean cold chains that will help to map a blueprint and delivery plan for sustainable cooling across the north Indian state. Professor Robin Mason, Pro-Vice-Chancellor (International) of the University of Birmingham and Director of the University of Birmingham India Institute, commented: "The University of Birmingham is a civic university with a global outlook. There exists a special bond between Birmingham and India which stretches back to the arrival of our first Indian students in 1909. ■

## Graham Wright to become HPA President

Graham Wright, legislation specialist at Daikin UK, is to take over as President of the Heat Pump Association (HPA) in 2019. Currently, Vice President, he will take over from Mike Nankivell who will stand down as president after five years in the role.

"It has been a pleasure to have had an active involvement with the Heat Pump Association since its inception in 1995 and a real privilege to serve the association as its President for the past five years. But I think now is the right time to step back and hand over to my Vice President, Graham Wright," said Mike Nankivell.

"The heat pump sector is entering a new period of challenges, with changes in the refrigerants landscape, government policies related to global environmental issues, national technology subsidies, building regulations and of course Brexit. Having retired from my 'day job' in 2015, while I



Graham Wright

remain committed to the success of the sector and am happy to continue supporting the Association, I believe the HPA needs to move forward with someone at the helm who is still at the sharp end of heat pump technology." Graham Wright has previously served as presidents of FETA, HEVAC and the BRA.

Mike Nankivell has announced he will be stepping down as the current president of the industry body at the end of the year. Graham Wright of Daikin UK will take over the presidency of the Heat Pump Association (HPA) next year. The position will see him helping to play up the role that the technology can play as part of a national low carbon heating strategy.

Wright will assume the presidency from Mike Nankivell, who announced he will be stepping down from the position at the end of the year. ■

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## eChiller Wins EC Award

**A** chiller which uses water as a refrigerant has won a major European Commission environmental business award. The eChiller is developed, manufactured and distributed by Efficient Energy GmbH from Feldkirchen near Munich. Efficient Energy was one of seven companies from six different countries to win the 2018-2019 European Business Awards for the Environment (EBAE).

The eChiller models are the only chillers worldwide which use the natural safety refrigerant water (R718) as the refrigerant, offer outstanding energy efficiency, and are manufactured in mass production. The eChillers already comply with the F-Gas Directive and any refrigerant-related safety requirements. The



eChillers' cooling capacities range from 20 to 45 kW depending on model, and the individual units can be scaled modularly to up to 300 kW. The refrigeration machines are ideally suited to cooling data centres and server rooms, buildings, switching cabinets and industrial processes.

The EBAE Prize is an initiative of the Environment Directorate-General of the European Commission. Proud to receive the award, Efficient Energy Managing Director Dr-Ing Jürgen Süß, said, "The environmental idea is firmly anchored in our company, but the economic aspect also plays an important role, and this award by the European Commission confirms once again the eChiller's market potential and our competitiveness." ■

## Danfoss Presents 10th Edition of Danfoss-ICE Awards

**D**anfoss India in association with Global Cold Chain Alliance (GCCA) India, presented the 10th edition of the Danfoss-Indian Cold Chain (ICE) Awards at a mega event that took place at Novotel Hyderabad Convention Centre, Hyderabad recently to recognise and reward excellence in the Indian cold chain industry that has been integral to realising the Indian Government's vision to transform India as the food factory of the world.

The annual Danfoss ICE Awards held this year was attended by Mahendra Swaroop, President, Federation of Cold Storages Association of India, Pawanexh Kohli, CEO & Chief Advisor, National Centre for Cold-Chain Development, Nagendra Rao Gubba, President, Chamber of Cold Storages Industry, Telangana, Atul Khanna, Director, ICE and Anuraaga Chandra, Director – Cooling, Danfoss India.

Given the increasing pace of urbanisation, major problems exist with respect to food safety as well as quantitative and qualitative losses, owing largely to inadequate rural electrification, low levels of organisation and limited knowledge of small holders about quality management through temperature management and good handling practice. The resulting losses negatively impact food security, nutrition and incomes of smallholders while increasing the cost of food for low income consumers. The development of appropriate cold chain systems (including low emission, renewable energy, new technologies) from farm to market, holds considerable potential for enhancing the safety, quality and shelf life of perishables, while increasing

returns to producers. It is against this backdrop that Danfoss along with GCCA and ICE instituted the Danfoss ICE Awards to specifically identify and showcase the best practices and excellence in Cold Chain to others.

Over the years several entrepreneurs, business model innovators, farmers consultants and more have been awarded. And now, we they are acting as change agents of this important sun rise industry, which we also believe is the next big job creator for India. Dr Ashok Dalwai, Chairman Committee on Doubling of Farmers Income, Ministry of Agriculture & Farmer's Welfare, Govt of India won the Danfoss ICE Exemplary Thought Leadership Award 2018. Under Dr Dalwai's chairmanship, the Committee on Doubling Farmers Income has brought about a paradigm shift in how the agriculture is understood and has positioned agri-logistics, including cold chain, as the backbone of the agricultural system. Dr Ashok Dalwai has not only contributed immensely to the field of agricultural economics but has played a vital role in redefining various concepts relating to agriculture and bringing the human factor to the fore.

Anuraaga Chandra, Director – Cooling, Danfoss India, said, "While India's agricultural output has grown five times in the last sixty years, the agricultural sector accounts for a mere 17.9 per cent of our GDP which stresses the need for the government and industries to invest in skill development and capacity building across the food infrastructure to reap the benefits of our hard-working farmers." ■



## Hitachi grabs Smart Air Conditioners Company of the Year Award

Adding another feather to its wing and cutting above the rest of the industry players, Johnson Controls-Hitachi Air Conditioning India was awarded as 'Indian Smart Air Conditioners Company of The Year Award 2018' by Frost & Sullivan that recognises and awards companies which show visionary growth, are inspired by innovation and demonstrate thought leadership abilities.

The award ceremony was held on 10th October 2018 in Hyatt Regency, Mumbai. More than five leading air conditioning companies were evaluated and nominated for this award. Hitachi rose above the rest and bagged this award. Winning this award has re-affirmed Hitachi's ability to constantly innovate and cutting-edge technology deployment to develop products that are synced with end consumer's requirement.

Frost & Sullivan's Best Practices Awards are presented every year to companies that have shown significant growth in their respective industries, have identified emerging trends before they become a market place standard, and have created advanced



JCH-IN's CMD Gurmeet Singh with Frost & Sullivan's Certificate

technologies that catalyses and transforms industries. The award is crafted through a rigorous process based on several parameters like product portfolio for maximisation, geographical coverage and penetration, customer value proposition, CSR activities etc. Frost & Sullivan's industry experts track markets and companies by holding detailed interactions with industry experts, market participants and end users along with an extensive research of proprietary data to compile the jury evaluation matrix. Nominees are shortlisted based on a structured data and a research backed presentation by Frost & Sullivan's senior industry experts. Evaluation by an eminent jury panel finally leads to the winner.

Hitachi's ability to deliver smart products come from its thorough understanding of consumer's requirement and insights gathered via various market researches. This helps the company in staying at the forefront to develop products and technologies that are innovative, energy efficient, eco-friendly and fulfill the needs of the customers. Smart AC range is equipped with features such as iClean, iSee, iSense and wi-fi technology that make the product stand out in the market. Hitachi's smart, energy efficient and eco-friendly products and technologies are backed by decades of experience in air conditioning in India. More than 18 per cent products in the line-up are 5-star inverter ACs and green as well. Hitachi has witnessed 24 per cent year on year in RAC segment. The company which manufactures room AC, VRF systems, Ductable AC, chillers and other commercial cooling solutions, has also bagged some prominent government and B2B segment clients such as Bangladesh Bhavan, Lodha Developers, Oyo Rooms, HDFC Bank, ICICI Bank, Kalpataru Group and Ajmera Group.

Thus, with such a strong foothold in the country and a strong portfolio, Hitachi has emerged to be a leader in the Indian Smart Air Conditioners Company of The Year Award category in India. ■



Frost & Sullivan Award

# Heat Pump Market worth USD 94.42 bn by 2023

The market is set to witness growth because of increased investments in the residential and commercial sectors, infrastructure developments, and ability to reduce carbon emissions.



Picture Courtesy: www.groehnac.com

Heat pumps provide a comfortable and 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 using equipment such as heat pumps.

In this report, the heat pump market has been analysed concerning four regions, namely, Asia Pacific, Europe, North America, and Rest of the World (RoW). The governments in these countries are drawing up policies to ensure that energy-efficient equipment such as heat pumps are being installed in new buildings, which are expected to drive the market for heat pumps. The demand from China would lead the market in Asia Pacific. Growing investments in the residential and commercial sectors of the Chinese market is creating a huge demand for the heat pump market. Rising government regulations and policies for increasing energy efficiency and favorable incentives, a significant contribution of heat pumping technology in the reduction of CO2 emissions, implementation of large industrial and commercial projects, and refurbishment of the aging infrastructure in Asia Pacific and Europe would continue to create demand for the heat pump market.

According to Marketsandmarkets report, the heat pump market is expected to grow from an estimated USD 54.34 billion in 2018 to USD 94.42 billion by 2023 at a CAGR of 11.68 per cent during the forecast period. The market is set to witness growth because of increased investments in the residential and commercial sectors, infrastructure developments, and ability to reduce carbon emissions.

Up to 10 kW rated capacity heat pumps are expected to hold a large share of the total market in 2018. This dominance is attributed to its large-scale application in the residential and commercial sectors and growing investments in those sectors.

The increase in urbanisation has led to the demand for smart buildings. These buildings require efficient heat pumps, leading to the growth of the heat pump market. Smart buildings are not only green or sustainable but are also intelligent; these buildings are equipped with advanced technologies, which include heat pumps.

To enable an in-depth understanding of the competitive landscape, the report includes the profiles of some of the top players in the heat pump market such as Daikin (Japan), United Technologies (US), Midea (China), NIBE (Sweden), Ingersoll Rand (Ireland), Glen Dimplex (Ireland), Stiebel Eltron (Germany), Viessmann (Germany), Panasonic (Japan), Mitsubishi (Japan), Vaillant (Germany), and Danfoss (Denmark). ■

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## Refrigerated warehouse makes every doorway count

New facility's doors separate ambient, refrigerated and freezer storage to reduce energy consumption while optimising uptime.

**G**andhi Automations is one of the leading diversified suppliers to the pharma sector, serving pan India customer accounts in more than 23 cities. Clean room doors (Prime Clean Reset) are designed for inside applications requiring limitation of leak flow. The perfect sealing properties of Prime Clean Reset provide environmental control and protect the inside environment against draughts, dust and dirt.



Clean room doors provided by the company also has self-repairing system.

One of the most imperative aspects of clean rooms is the door for clean room facility. Time for which door is open will play a critical factor in avoiding dirt, temperature, humidity etc. Opening and closure of door has to quick enough to isolate the two areas.

Gandhi Automations provides Clean Room High Speed Doors specifically designed for the above purpose. Its Clean Room High Speed Doors are the best suited for pharma industry where one needs to control environment. The opening and closing of door are fast enough to separate two areas.

In the high-volume, 24/7 facility, turns in the cooler happen twice a day and, in the freezer, inventory turns occur every day and a half. With traffic streaming in and out of the building through 47 dock doors, losing a single high-traffic door could severely jeopardise deliveries.

Prime Freeze High Speed Doors are a perfect solution where cold storage with negative temperatures to as low as  $-22^{\circ}\text{F}$  is required. The curtain is made of reinforced PVC vinyl with heated side guides. Optionally, a special and innovative insulated flexible



curtain is also available. High Speed Freezer Doors are the solution when temperature control is critical and where forklift traffic is high.

"If a cooler door is down, that could be detrimental to our operation," says warehouse manager, who notes that a single inoperable door could cost 30 per cent of shipping capacity. "We cannot afford to lose an opening. We are hard on things, and that's why we need durable doors."

High-Speed Freezer Duo Doors not only help to maintain temperature but also aid human safety. These Doors have a revolutionary soft bottom edge and sensor combine to ensure operator safety at all times. 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, the 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/dryer to maintain temperature balance.

Fast door speed also reduces the likelihood of panel collisions with tall-mast forklifts. In the event of a collision, the self-repairing system automatically resets the panel back into its guide without human intervention.

To avoid accidental contact with door panels, an LED safety light system along the door columns warns employees when the door is about to close and when it is actually closing. Two photo eyes, (cells) a dual-pneumatic reversing edge and threshold warning lights will reverse the descending door panel if an employee is in the doorway. ■

# Green Refrigerants



Photo Credit: www.rischoice.com

Gaining momentum globally due to their zero Global Warming Potential (GWP) and Ozone Depletion Potential (ODP).

– Supriya A Oundhakar, Associate Editor

The global heating, air conditioning, and refrigeration (HVACR) industry has been witnessing a shift towards use of refrigerants with lower carbon footprint. Refrigerant that transfers the heat between the indoor unit and the outdoor unit of air conditioners is taking a toll on the environment as it depletes ozone layer and also contributes to global warming.

In the beginning, Methyl Chloride, Methyl Formate and Ammonia were used as refrigerants for mechanical refrigeration systems. Toxic nature of Methyl Chloride and Methyl Formate paved the way for the introduction of Chlorofluorocarbons (CFCs) and Hydrochlorofluorocarbons (HCFCs) having high thermodynamic efficiency and non-toxic nature. Later, CFCs and HCFCs were replaced by hydrofluorocarbons (HFCs) due to

environmental concerns about depletion of the ozone layer. However, Kyoto Protocol to the Framework Convention on Climate Change put HFCs under scanner due to their impact on the environment.

The Montreal Protocol, the Kigali Amendment, the Convention on Climate Change (COP21) etc. have been adopted in order to lower or eliminate the impact of these Global Warming Potential (GWP) and Ozone Depletion Potential (ODP) refrigerants. The Montreal Protocol voted to phase down HFCs. The Kigali Amendment provides for a gradual phase down the production and consumption of HFCs based on their GWP value. This has generated urgent need for green refrigerants.

For years, the most common refrigerant gas used in air

Table 1: Main characteristics of the most commonly used natural refrigerants

Refrigerant	ASHRAE Number	Formula	Safety Group	GWP	ODP	Critical Temperature (Deg C)	Critical Pressure (bar)	Normal Temperature (Deg C)
Carbon dioxide	R-744	CO <sub>2</sub>	A1	1	0	31.2	73.8	-79
Propane	R-290	C <sub>3</sub> H <sub>8</sub>	A3	3.3	0	96.7	42.6	-42
Isobutane	R-600a	C <sub>4</sub> H <sub>10</sub>	A3	4	0	135	36.5	-11.7
Propylene	R-1270	C <sub>3</sub> H <sub>6</sub>	A3	1.8	0	92.4	46.3	-48
Ammonia	R-717	NH <sub>3</sub>	B2L	0	0	132.4	112.8	-33

conditioning systems was R-22, which in the past was viewed as a safe refrigerant. However, it depletes the ozone layer and the industry is aware of this and some have taken measures to curtail its effect on the atmosphere.

“After understanding impacts of manmade refrigerants on the environment, we all are now looking for more sustainable products. Montreal Protocol was one big step to save environment and now after Kigali agreement, we are looking for natural or green refrigerant,” asserts Anand Joshi, Immediate Past President Association of Ammonia Refrigeration and Member ASHRAE (USA), IAR (USA), IGCC, IETE, IDA, RATA.

An ideal refrigerant would satisfy certain conditions such as zero ODP, very low GWP, less CO<sub>2</sub> emission by virtue of reduced power consumption. In addition, the toxicity and flammability of the green refrigerant should be within tolerable limits.

According to Vikash Sekhani, Director, Dry All, “These are chemical free refrigerants and do not pollute atmosphere, water or biosphere. Their production is not energy intensive as even the hydrocarbons can be obtained without chemical transformation. Natural refrigerants are widely used in some RAC applications, for example isobutane in domestic refrigerators and ammonia in large cooling processes.”

Natural refrigerants such as Ammonia, Propane, Isobutane, R-32, CO<sub>2</sub> and the newly developed Olefin group of refrigerants may be considered as green refrigerants under today’s scenario. In addition, air and water may also be considered as green refrigerants, although their application areas are limited.

According to Professor Bijan Kumar Mandal, Department of Mechanical Engineering, Indian Institute of Engineering Science and Technology, the Hydro-olefins (HFO) group are the best examples of green refrigerants as they have zero ODP and extremely low GWP values (GWP ≤ 6). Some common refrigerants belonging from HFO group are R1234yf, R1233zd, and R1234ze. In present scenario, global refrigerant manufacturers are blending HFO and HFC components to create low-GWP blends like R448A and R449A designed to match the characteristics and performance of mainstream HFCs. “These refrigerants give higher capacity with minimum power requirement,” informs Sekhani of Dry All.

According to Carel which provides control solutions for HVACR, the main characteristics of the most commonly used natural refrigerants are summarised in Table 1.

As per Carel, Carbon dioxide (CO<sub>2</sub>, R-744) being a non-toxic substance is classified as A1 according to ASHRAE Standard 34. The effect of R-744 on the ozone layer is null, having an ODP value of 0. As regards its global warming impact, their GWP is 1, which is as compared to the direct impact of other refrigerants. However, it can be considered that R-744 does not contribute to climate change since it is a product from industrial processes and would otherwise be emitted into the atmosphere.

Hydrocarbons are odourless organic compounds made of nothing more than carbon and hydrogen atoms. They are flammable, and therefore, their safety classification is A3. Its ODP of 0 and extremely low GWP value mean they are harmless to the



### Anand Joshi

Immediate Past President Association of Ammonia Refrigeration and Member ASHRAE (USA), IAR (USA), IGCC, IETE, IDA, RATA.

“After understanding impacts of manmade refrigerants on the environment, we all are now looking for more sustainable products. Montreal Protocol was one big step to save environment and now after Kigali agreement, we are looking for natural or green refrigerant.”

ozone layer and do not contribute to global warming. Propane (R-290), Isobutane (R-600a) and Propylene (R-1270) are the most common hydrocarbons currently used in HVACR. Hydrocarbons operate at standard working pressures and have excellent thermodynamic properties, leading to high energy efficiency. Latent heat of vaporisation of hydrocarbons is almost two times higher than that of the most common HFC refrigerants. The major challenge of the use of Hydrocarbons as refrigerants comes from their high flammability. Hydrocarbons are technically viable for small and medium-sized refrigeration and air-conditioning applications as well as chillers domestic fridges, beverage coolers, vending machines, industrial refrigeration, transport refrigeration, small air conditioning systems and water heaters.

Ammonia (NH<sub>3</sub>, R-717) is an alkaline and colourless chemical compound at atmospheric pressure. Being a mildly flammable, it is classified as B2L. R-717 is also corrosive, but its strong odour makes it easy to detect. Regarding environmental impact, it does not have any impact on the ozone layer and global warming when released into the atmosphere, thus its ODP and GWP values are 0.

R-717 is widely available in the market at a very low price. However, the toxicity and flammability of R-717 has limited its used in public places. Many advances have been made recently to health, such as the development of hermetically sealed equipment or leak detection systems.

## Green Refrigerants in India

Natural refrigerants have gained momentum globally due to their zero GWP, ODP and the evolution of technology for their safe use. Green refrigerants have also found applications in Indian HVACR industry owing to environmental concerns. As a result, Indian system manufacturers are treading the path of natural refrigerants in order to comply with Montreal Protocol and Kigali



### Vikash Sekhani

DIRECTOR, DRY ALL

“These are chemical free refrigerants and do not pollute atmosphere, water or biosphere. Their production is not energy intensive as even the hydrocarbons can be obtained without chemical transformation.”



**Professor Bijan Kumar Mandal**  
 Department of Mechanical Engineering,  
 Indian Institute of Engineering Science and  
 Technology, Shibpur

“There will be no alternative in near future other than using green refrigerant not only in India, but also across the entire globe.”

Amendment. They have started investing in R&D of green refrigerants. Vikash Sekhani of Dry All says, “Now, in India many system manufacturers are moving towards environment friendly refrigerants such as Propane, Butane, R32, R410A, NH3. Many Indian manufacturers have started manufacturing components to support this effort of OEM to move to green refrigerants.”

Ammonia is one of oldest refrigerants being used in air conditioning and refrigeration industry since 1875 and in India it has been used since 1914. While talking about the acceptance of natural refrigerants in India, Anand Joshi says, “The use of Ammonia as refrigerant has various industrial refrigeration applications such as ice, meat, poultry, dairy, ice cream, breweries, beverages, seafood or aqua culture processing, cold storage, vegetable freezing, chemical, dye stuff, pharmaceuticals, bulk drug and many more. Indian technicians are conversant with Ammonia. It is the cheapest refrigerant.”

The use of R32 refrigerant as natural refrigerant in air conditioning systems is gaining prominence due to its zero-

depletion potential and the initiative of the global industry as a part of the phasedown program introduced by the Montreal Protocol and Kigali Agreement. Daikin is the first company in the world to have successfully used R-32 in air conditioners.

Some Indian refrigeration and air conditioning manufacturers have already implemented R32 as a green alternative to R410a. R452A being a non-flammable HFO blend is implemented in transport refrigeration. CO<sub>2</sub> is used in supermarket applications in as it is widely implemented in sub-critical and trans-critical cycles. However, sub-critical cascade systems with a R134a primary refrigerant and a R744 secondary refrigerant can be upgraded easily to a non-flammable HFO blend such as R513A, asserts Mandal.

Honeywell is a global leader in the development and production of high-performance Fluorocarbon refrigerants and thermal working fluids. Honeywell develops HFO 1234yf as a replacement for R134A in mobile air conditioning applications. Honeywell Genetron Performax LT (a ternary blend of HFC-32/HFC-125/HFC-134a), serves as a non-ozone depleting replacement for HCFC-22 in various commercial refrigeration applications, particularly in low-temperature applications. Genetron 422D and 407C are non-ozone-depleting HFC based refrigerants for replacement of HCFC-22 in air conditioning systems. In fact, there will be no alternative in near future other than using green refrigerant not only in India, but also across the entire globe, he elaborates.

The cooling industry has always proactively addressed environmental concerns and will continue to do so in the future. ■

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## 75F introduces Smart Stat Zone Controller

75F, a wireless building automation solution for commercial buildings, announced the release of the 75F Smart Stat Zone Controller, the smartest commercial thermostat on the market. Smart Stat supports the new WELL building standard with immediate data insights for temperature, humidity, CO2, VOCs, light, sound and occupancy from built-in sensors. Each Smart Stat also has a unique radial touch user interface and includes 75F's Cloud-based wireless building automation platform for HVAC, Indoor Air Quality, lighting and energy management to achieve energy savings in the 30-50 per cent range in commercial buildings.

"This is the smartest commercial thermostat in the world. It can optimise occupant workspaces, zone by zone, minute by minute," said Deepinder Singh, Founder & CEO of 75F, Inc. "With the 75F Smart Stat, buildings can begin to work smarter for occupants, sensing their indoor air quality and improving productivity."

Key features of the 75F Smart Stat include the following:

- **Personalised Zone Control for Maximum Productivity and Comfort:** The 75F Smart Stat delivers immediate zone sensing and remote monitoring with real-time data visibility to assure workplace environment quality and pinpoint issues.
- **IoT-driven Zone Controls for HVAC Applications:** The 75F Smart Stat controls existing HVAC equipment as a quick-install retrofit or new-build solution.
- **Smart Building Automation System (BAS) and Energy Management System (EMS) with Predictive Cloud Computing:** Smart Stat delivers 'Building Intelligence in a Box' with fast installation easy Bluetooth pairing, and no custom programming required. Machine learning factors building position and load history, real-time on-site sensors, and weather feeds to predictively manage zones for optimal comfort and 30-50 per cent improved energy efficiency.
- **Web and mobile access:** The suite of applications in 75F's Facilising gives owners and facility managers remote monitoring and visibility into live building and equipment performance data across multiple sites, floors, zones and equipment to assure optimal environments and diagnose equipment problems. An occupant app includes temperature and lighting control, geofencing and feedback tools.
- **Secure Wireless Mesh Network:** Unlike direct Wi-Fi connected thermostats, Smart Stat uses a secure, proprietary 900 Mhz mesh-network for lightweight, best path communications between devices and with the 75F Central Control Unit (CCU). ■



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# Challenges in Food Cold Chain

Lack of transport infrastructure, cold chain facilities and non-application of supply chain management principles are making the agri-business in general and the food processing sector in particular very inefficient in India.



Photo Credit: www.solarfreeze.co.ke

A cold chain is a temperature-controlled supply chain cold storage and distribution in which agricultural products are preserved afresh and shelf-life is extended for a longer period of time. With increasing food demand and changing lifestyle, cold chain has become the focal point for the government and investors. This industry facilitates long distance transport of

various perishable products and seasonal fruits available for the entire year. It's a kind of linkage between the farmers and consumers. This integrated system helps in maintaining quality in terms of nutritive value, crispness, freshness, taste and appearance. India is one of the largest producers and a leader of various agricultural products. But due to fledgling cold supply chain, there is a heavy loss of

food and other resources. These losses have been stated to be as high as USD 8 to 15 billion per annum from the agriculture sector alone. There is a need to develop cold chain sector to avoid these problems. The cold chain industry has been growing at a CAGR of 20 per cent for the last three years i.e. from 2014 to 2016. The cold chain market in India is anticipated to reach Rs 624 billion (USD13 billion) by the



Figure 1: Cold chain supply network.

end of 2017. Cold stores are the major revenue contributors of the Indian cold chain industry. But it still lacks proper infrastructure as India has capacity below 1,000 MT of products. However, lack of proper and adequate food storage, processing and cold chain logistics remain a serious challenge. Though, the Indian Government is one of the driving forces in developing the cold chain industry and supports private participation through various subsidy schemes and grants. Investment in cold chain in India was also opened under the automatic route for 100 per cent FDI participation.

Efficient Supply Chain Management (SCM) is an essential feature that is responsible for the rapid growth of any country's economy. As the competition has increased globally, developing countries like India have now shifted their focus to producing non-traditional agriculture goods. This change has improved not only their export capacity but also the enough availability of food within the country. Despite having such an increased agricultural capacity, a huge part of Indian population is still struggling to fulfill their basic needs. The actual concern that has to be addressed is not the food producing capacity but the capability of storage and distribution. This has led the governments of many countries to think about the various

means of food safety. This would also enable the government to give away the benefits of revenues through agricultural products to the farmers. The farmers in many developing countries including India usually come across many challenges in identifying and accessing the economical ways of diminishing the risks to their produces and stand in the match with the big food producers who can produce in moderate quantity. Such a jeopardy condition leads to the increased requirement for efficient supply chain management. Cold Chain Supply is the best possible option to fulfill this requirement.

India is a fast-growing economy with a large agricultural base. But lack of transport infrastructure, cold chain facilities and non-application of supply chain management principles is making the agri-business in general and the food processing sector in particular very inefficient. Recognising this, the Government of India has initiated several steps including creation of a separate ministry for food processing industries, opening up the agriculture sector for foreign direct investment through the agri export zones and special economic zones, and in several other ways. India aims to be the food factory of the world and increases its share in global food trade from 1 per cent to 3 per cent.

## Cold chain supply

Cold Chain Supply (CCS) is relatively a recently adopted concept in the supply chain management. It is significant to understand the concept appropriately to execute the operations of Cold Chain Supply (CCS). The literature defines the CCS or also known as Cold Chain Management (CCM) as:

"A network of refrigerators, cold stores, refrigerated trucks, freezers and cold boxes organised and maintained so that the perishable items are kept at the right temperature to remain fresh and intoxicated during their transportation, storage, and distribution from factory to the point of use."

An environment-controlled logistics chain, ensuring an uninterrupted care from source-to-user, consisting only of the activities related to storage, and distribution in which the inventory is preserved within predetermined environmental parameters. The Cold Chain does not alter the essential characteristics of the produce or product handled.

The cold chain supply has proved to be a suitable and uninterrupted storage as well as distribution model for food safety concern of the country. Every year, a huge quantity of perishable goods like as food, vegetables, flowers, meat, fruits, and medical drug or vaccines, etc. gets wasted only because of unavailability of on-time storage and distribution capability in India. Cold Chain Management or Supply (CCM/ CCS) has a significant impact on farmers, and the companies working in food industry. Modernised cold-chain development with controlled temperature



Figure 2: Cold chain supply cluster with all stakeholders

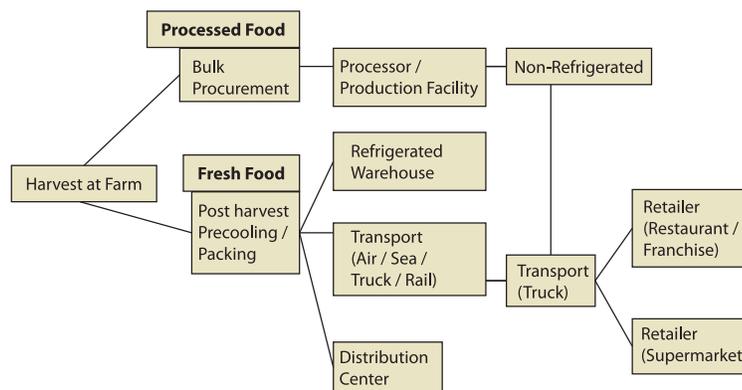


Figure 3: Process in cold chain supply of food.



Figure 4: Growth in Cold chain supply sector.

generally focuses on one supply chain and not on the network of channels (Figures 1 and 2). As shown in figure 1 and 2, CCS is a separate series of storing and supplying activities leading to scheduled delivery of the product to end consumers, and consequently satisfy them as shown in Figure 3.

The cold chain industry in India is still at a nascent stage. Although, there is a large production of perishables, still the cold chain potential remains untapped due to certain reasons like high share of single commodity cold storage, high initial investment (for refrigerator units and land), lack of enabling infrastructure like power and roads, lack of awareness for handling perishable produce and lapse of service either by the storage provider or the transporter leading to poor quality produce.

However, increasing urbanisation and growth of organised retail, food servicing and food processing sector are boosting the growth of cold chain industry in India. The trend is shifting towards establishing multi-purpose cold storages and providing end-to-end services to control parameters throughout the value chain.

As Food and Agricultural Organisation (FAO) estimates that a 45 per cent increase in food production and availability needs to be achieved by 2030 as shown in Figure 4. It is to ensure adequate food supply to over nine billion inhabitants by 2030 which would be a huge challenge for the world. Thus, it is vital to explore every possible means of achieving progress, particularly, the reduction of post-harvest losses. Losses of perishable foods are the most important in developing countries where

over 80 per cent of the global population lives, and where about one quarter of the production is lost due to a lack of an incomplete cold chain. These losses represent more than 400 million tons per year. Large post-harvest losses affect food security to the rural economies by markedly widening the gap between consumer prices and the amounts the producers are being paid at the end. They make products less affordable for consumers, and reduce farmers' income, thus, discouraging them from producing and supplying markets. Table 1 shows the range of temperature of the food product storage. Also, it has competencies in the cold chain management, particularly, in the storage and transport of food items and in managing their supply and demand networks.

### Benefits of Cold Chain Supply

Having compared the system requirement of cold chain supply, the advantages are summarised as follows:

- Better product quality in terms of nutritional value, colour, texture.
- No bacteria formation takes place due to proper cold storage conditions.
- Maintenance of hygiene.
- Maintained humidity.
- Longer storage of product or extension of shelf life.
- Value for money.
- Development of packaging industry.
- Address the issue of traceability.
- Better handling and Hygiene practices.
- Inventory management and automation.
- Palletised handling and racking.
- The growth of refrigerated transport industry.

Table 1: Predicted loss of fresh food storage at various storage temperatures

Food product storage	At optimum cold temperature	Optimum temperature +10°C	Optimum temperature +20°C	Optimum temperature +30°C
Fresh Fish	10 days at 0°C	4-5 days at 10°C	1-2 days at 20°C	A few hours at 30°C
Milk	2 Weeks at 0°C	7 days at 10°C	2-3 days at 20°C	A few hours at 30°C
Fresh Green Vegetables	1 Month at 0°C	2 weeks at 10°C	1 Week at at 20°C	Less than 2 days at 30°C
Potatoes	5-10 Months at 4-12 °C	Less than 2 months at 22°C	Less than 1 month at 32°C	Less than 2 weeks at 42°C
Mangoes	2-3 weeks at 13°C	1 week at 23°C	4 days at 33°C	2 days at 43°C
Apples	3-6 months at -1°C	2 months at 10°C	1 month at 20°C	A few weeks at 30°C

## Challenges to Cold Chain Supply

The key challenges to the growth of this sector are:

**High Energy Consumption Cost:** Operating costs for the cold storage business in India are approximately Rs 80-90 per cubic foot per year as compared to Rs 40 per cubic foot per year in the West. Energy expenses alone make up about 30 per cent of the total expenses for the cold storage industry in India compared to 10 per cent in the West. These factors make the business of setting up of cold storages a high entry barrier.

**Rising Real Estate Costs:** A fully integrated cold storage facility with one million cubic foot of storage space will require an area of an acre to build, which could cost between Rs 1 crore and 1.5 crore, constituting 10-12 per cent of the project cost. Cooling units are not mobile units, and so location becomes a key factor, and with India's small land holdings, getting large tract of land to build a cold storage unit becomes a major additional constraint.

**Lack of Logistical Support:** Cold chain industry in India is fragmented and it will require heavy investment in building technology enabled cold storage facilities to cover entire value chain from procurement to transportation in refrigerated trucks to retail outlets in cities.

**Akash Joshi**

UG Scholar in Mechanical Engineering Department at GEC, Dahod, GTU, Ahmedabad



## Large and Unpredictable Variations in Quality

**Uneven Distribution of Capacity:** A majority of investment in setting up cold storages in India has been in states like Uttar Pradesh, Uttaranchal, Maharashtra, Gujarat, Punjab and West Bengal. Secondly, cold storages that have been set up can cater to single commodities only which are major bottleneck.

## Strategies to Overcome Challenges Faced by Cold Chain Supply

- Easing of import rules for cold chain equipment including refrigerated vans.
- Developing FPOs and FIGs and enabling them to develop direct market links.
- Developing improved business models by promoting producer owned supply chains.
- Amendments to APMC aimed at enabling direct market driven supply chains and opening options through alternate market channels.
- Continue extant grants and subsidy schemes for cold chain infrastructure development and extend the schemes to include the logistics and transport sector.
- Develop multi-model cold chain links through rail and highways; aiming at a

**Lalkiya Deep**

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fast track green corridor for perishables.

## Conclusion

Innovations in packaging, fruit and vegetable coatings, bio-engineering (controlled ripening), and other techniques reducing the deterioration of food products have helped shippers extend the reach of perishable products. For food products such as fruits and vegetables, time has a direct impact on their shelf life and therefore, on the potential revenue a consignment may generate. Concomitantly, new transport technologies have permitted the shipment of perishable products over longer distances. Various parameters have been recognised by the Indian Government and 100 per cent FDI in the cold chain has already been permitted country needs to ensure that their production does not go waste and returns fair value to producers and consumers There must be a better linkages and way of transportation between growers, storage and customers. There is absence of a single dedicated perishables gateway or fast track corridor for perishable cargoes. Consumer food retail sector is the fastest growing in the country, worth around 15 billion USD 40 per cent of fresh produce is wasted due to lack of satisfactory handling in the supply chain Indian cold chain business is fragmented in a big way. ■

**Dr. (Prof.) D.B. Jani**

Associate Professor, GEC, Ahmedabad



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## TESSOL anticipates fast-paced growth for cold chain industry

Rajat Gupta, CEO, TESSOL gives insights on performance of Indian cold storage and transportation in an email interaction with Cooling India.

### How has been TESSOL growth journey so far?

TESSOL is a very different from the most manufacturing or product companies in India. We have a mission to create sustainable and affordable cold chain solutions from farm to fork. In that endeavour, we work hand in hand with our customers and innovate on multiple fronts including technology, product and business model. Over the last five years, we have had a phenomenal growth in our product portfolio and customer base, we have touched all commodities across the perishables space and are now reflecting corresponding growth in our revenues.

### What is your take on the recent performance of Indian cold chain storage and transportation sector?

I strongly believe in the need of cold chain across the value chain for specific commodities – the question however comes on its economic viability. I think, while the cold storage and transportation industry has built capacity to provide these services, the cost of such operations (especially, transport) remain high for the users and they still think of it as a premium service. If this is the case, the government will need to keep giving infrastructure subsidy and it will always be a niche segment. The product innovators and service providers need to work together on solutions that can overall reduce these costs and help us scale this industry to a level where there are cost economies of scale and cold chain becomes mainstream.

### What are the growth drivers of your business?

The key drivers for our business include growth in food processing industry, home delivery, e-commerce and urban distribution of perishables.

### What is TESSOL's current portfolio of cold chain storage and transportation projects?

We are currently integrating the last mile connectivity of three of the largest online grocery retailers in the country. We have deployed our technology successfully for urban distribution application with large 3PL players and ice cream companies.

### What are some of the significant projects in the pipeline?

We plan to build on the above product segments with a larger set of customers over the next one year.

### How do PLUGnCHILL products help to bring efficiency in cold chain operations?

PLUGnCHILL is a plug-in energy storage technology which eliminates the use of any engine power for cooling. Therefore, it reduces the diesel consumption and the cost of transportation by up to 60 per cent. Given its independence from the engine and its RPM, it gives excellent temperature performance during city movement (even with multiple openings) which is characterised

by low speed and extensive stoppages. The technology based on thermal energy storage ensures that there is no product spoilage even if the vehicle primary engine fails therefore protecting client's valuable cargo. Our newly introduced 'SWAP' unit is ideal for tertiary distribution and multi-temperature application. With SWAP, one can bring down the total cost of transportation very close to 'Dry Cargo'.

### How does the company plan to expand its presence in cold storage and transportation in India?

We are dominant in the West of India given our origins. We also have good number of assets in the South and now in North for our key account customers. Our plan is to set up service centers and backup operations before we expand into a new territory. We are currently in the process of doing that in the North and East. Once we have that infra in place by end of this FY, we will expand rapidly in these geographies.

### How technology is defining your business' future?

Our venture is based on the use of latest refrigeration technology at the core and hi-technology for improving the operations and experience of our customers. We work closely with stakeholders on the remote monitoring business using GSM and Wi-Fi technology. Internally, we use technology for monitoring our helplines, service requests and system performance.

### What are some of the key issues and challenges for the company? How are these being resolved?

Current challenges are all typical challenges that come with business growth and expansion. We have strengthened our top management team so that there is strong focus on detail even while growing rapidly.

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

We are optimistic about the future of this industry and anticipate an accelerated growth. I believe that given various growth drivers and the lack of existing infrastructure in India, the high growth rates should continue at least over the next four to five years. ■

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# Getting the Best Out of AHU

The article describes the key factors that impact the performance of an AHU and the approach to exploit the unit in the most optimal manner.

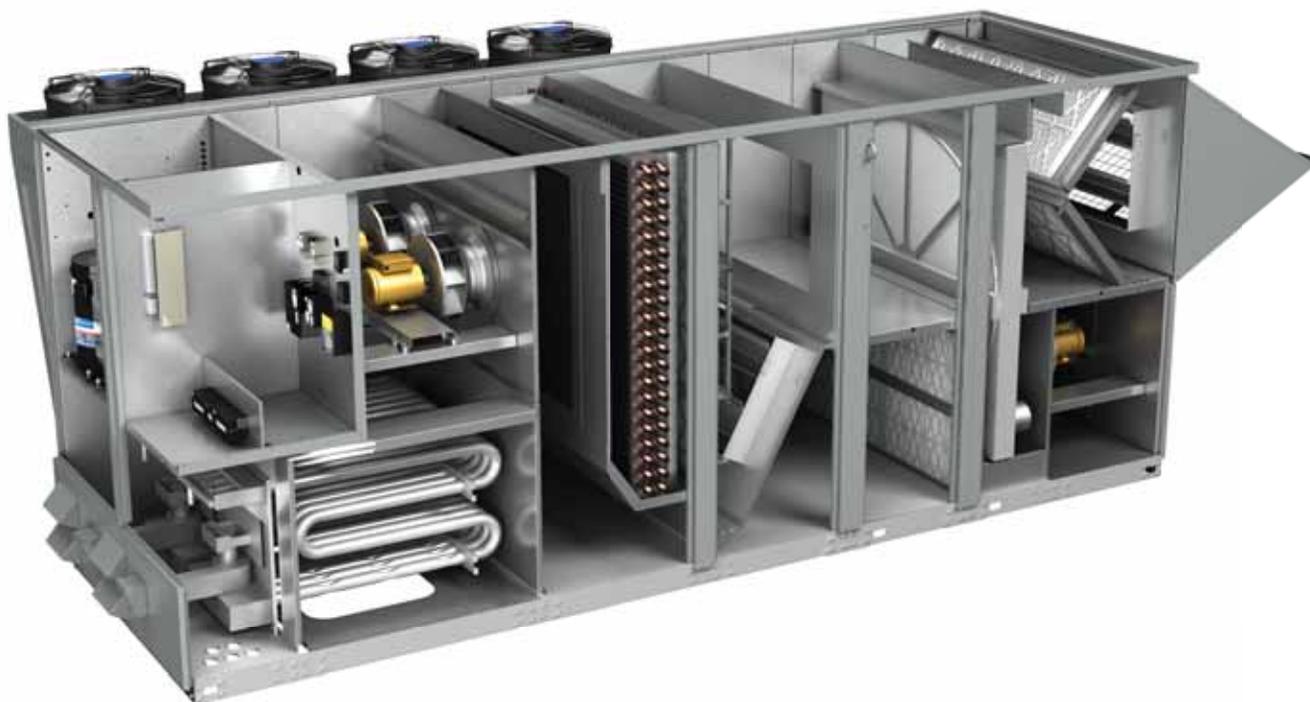


Photo Credit: [www.valentair.com](http://www.valentair.com)

A key component of a building or office air conditioning system is the Air Handling Unit (AHU). While there is a large amount of design considerations that go into the selection of the main chiller and the associated systems, AHUs usually do not get the same attention. The AHU with the matching ventilation characteristics is chosen, installed and put into operation. This is, however, not the best way to get the best out of the overall HVAC system of the building. Taking the case of a typical commercial building running a central water-cooled chiller, there will be 2 – 3 chillers but the number of AHUs will be many, typically, one per floor and in some cases where the floor plate is large, there

may be even two per floor. Thus, the energy consumption as well as the impact on the occupants is larger for the AHUs.

In addition to the selection of the AHU, a key component of getting the right output from an AHU is the installation, commissioning and subsequently, the performance management of the unit. An incorrectly installed AHU can lead to various deficiencies such as higher noise, poor air flow, higher energy costs etc. Similarly, once the AHU is put into use, there occur changes in the space that the AHU ventilates. This could be due to changes in the space usage, increased occupancy etc and thus, the AHU then operates at different conditions from the design. The performance will, thus, get

impacted leading to poor or improper air flow rates as well as higher energy costs.

AHUs are critical to the efficient operation of the overall HVAC system and the O&M team needs to pay special attention right from the installation stage up to the day to day operations. This article describes the key factors that impact the performance of an AHU and the approach to exploit the unit in the most optimal manner.

## Overview of AHUs

Double skinned AHUs, with insulated panels and sophisticated measurement and control systems are now standard in the grade A building that we see. The key components are the supply fan which

circulates the air, filter, the fan motor, the cooling coil for heat transfer from the air to the chilled water, damper and the casing. AHUs are usually of the draw through type where the fan is after the filter and cooling coils. Approximately 15 per cent of the energy used in a building is consumed by fans and hence, it is important that the AHUs are not only specified correctly but also installed and operated in the right manner.

## Installation Aspects of AHUs

This is the start point of a good AHU operation. The AHUs is typically installed towards the end of the construction phase and in most of the cases, in a hurried manner resulting in physical damage to the coils or the filters. At times, due to poor planning, the AHU room does not have enough space for a maintenance engineer to move freely or allow easy access to the inside of the AHU for maintenance as well as monitoring activities. Some of the key aspects to keep in mind when installing AHUs are:

- Vibration insulation devices should be correctly positioned
- Access doors should be accessible
- Motor should be safeguarded from the water in the air which can lead to condensate settling.
- Drain points and the slope is very critical to prevent micro biological growth in the unit
- Correct alignment of the Fan and motor
- Belt tension
- Clean the filters and coils before go live

## Testing and Balancing (TAB)

A planned and robust TAB cannot be over emphasised. Most problems occur due to the installation team not carrying out a full testing of the unit and making corrections to the air flow. This can lead to long drawn out discussions between the operations team and the project implementation team as well as impact on the occupants. Poor balancing will lead to either low or high air flow at the exit points which in turn will create hot or cold spots. If the fan speed is inadequate, it will lead to wastage of energy or in cases where flow is low, the air quality will get impacted. 5-

10 per cent of energy can be wasted if the system is poorly balanced. The key aspect to keep in mind during the commissioning phase are

- Total system static pressure should be less than 500 – 625 Pa
- Air velocity should be in the range of 2000 -2400 fpm
- Adequate test openings should be provided in the AHU to allow for testing the system during the later phases of the AHU life when any changes in the system are carried out or a performance test of the AHU is needed.

## Handling Changes in the Work Space

The AHU is selected based on certain design guidelines -no of people, space usage, load, static pressure, no of openings etc. In most cases, the design usage changes – sometimes very quickly at the start of the AHU life and in other instances, later in the life of the building. Since the AHU has a direct impact on occupant comfort which in turn effects user productivity, changes are required to be undertaken to the AHU by the operational team. The factors that impact the AHU performance the most are the fan speed and the cooling coil efficiency.

### Checking Adequacy of Fan Speed

At the time of system design, the flow rates are designed with some safety margins in terms of the pressure drops in the ducting. When the system is put into use, if the estimation is off the mark or the space layout has changed, there will be excessive air flow at the end points which will lead to higher noise levels. The solution to this may be change the fan or motor in extreme cases. However, by calculation the new system requirements, this can be avoided. The CFM is a function of the rpm (direct), static pressure (square) and motor current (cube). Using these relationships, and the fan curves, the speed of the fan can be changed to reduce the air flow and hence, the noise.

### Checking the Cooling Coil Performance

When the space load changes due to increase or decrease in the occupancy, or

addition of more equipment in the space, the performance of the cooling coil should be checked to see if it is adequate to meet the requirements. This typically happens when the building use changes or there is a change in the number of people operating from the space. Cooling coil performance should also be checked if the occupants complain of the space being too hot or cold on a frequent basis. The O&M team can easily calculate the performance (cooling capacity) of the AHU by measuring the temperature of air entering the coil and temperature of water entering. Using these two parameters and the cooling capacity for a known operating point (obtained from the operating manuals), the operator can find the additional cooling capacity needed.

## Conclusion

While there are many critical components in the HVAC system of a building, the AHU has a very important role to play in both the system operating efficiently as well as in managing occupant comfort at the desired levels. A breakdown in the chiller may not be noticed by the occupants immediately as the air flow is maintained by the AHU. However, if the air flow stops or is inadequate, there is instant occupant awareness. On the other hand, there are many factors that can affect the functioning of the AHU such as change in the occupancy, change in use of the space etc. Thus, the O&M engineer should have a thorough knowledge of the AHU system and continuously monitor the performance of the system to see that the design specifications are achieved. The AHU is a simple device and a robust planned preventive maintenance plan, enhanced with a performance assessment of the coiling coils and fan speed at regular intervals will go a long way in saving operating costs as well increase the occupant comfort. ■

**Aneesh Kadyan**

Sr Director - Operations,  
certified Energy Auditor and  
an IGBC Accredited  
Professional (AP)



# Achieving Energy Efficiency in HVAC & Refrigeration Systems

The article reviews the methods through which energy saving can be achieved. Basic refrigeration process and their monitoring can be performed by evaluating energy performance. The article also gives information about a small case study, by which one can select the electric motor for a refrigeration compressor.



Photo Credit: www.dnml.com

**H**VAC system consists of a chain of components designed to cool or heat, ventilate a specific area while maintaining a defined environmental cleanliness level. Purpose of HVAC system is to control or maintain temperature - heating, to purify the air - ventilation and to control or maintain humidity - air conditioning. Climate control systems typically account for a substantial part of energy consumption in commercial buildings. 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, ventilating and air conditioning are interrelated, especially, installation, operation and maintenance costs. The obligations established in global agreements as well as regulations and legislation that limit the energy consumption and greenhouse gases emissions gave a novel importance to the HVAC systems rating.

One of the key points of the inspection procedure is the availability of reliable energy performance data of the main components of the HVAC system. This task is usually easy for heating only systems, such as gas boilers coupled to hydronic heating plants, but much more complex for systems delivering both heating and cooling. In the latter case, in fact, most system equipment (e.g., water chillers, cooling towers, fans, chilled / hot water pumps, fan coils, etc.) are electrically-driven, but the electricity consumption is seldom measured in a disaggregated way. Normally, the only available electrical consumption data are those measured at the main incomer, and

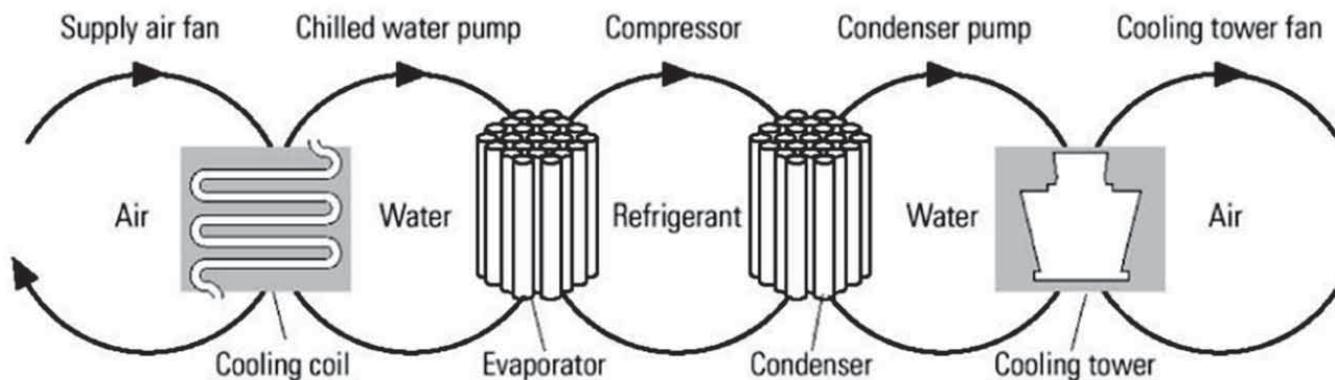


Figure 1: Heat Transfer Loops in Refrigeration System

therefore, also includes the contribution of lighting and appliances. One of the main problems is that the definition of energy data collection protocols, suitable for an effective inspection and energy auditing process of existing HVAC systems.

Air conditioning and refrigeration consumes significant amount of energy in buildings and in process industries. The energy consumed in air conditioning and refrigeration systems is sensitive to load changes, seasonal variations, operation and maintenance, ambient conditions etc. Hence the performance evaluation will have to take into account to the extent possible all these factors.

The purpose of performance assessment is to verify the performance of a refrigeration system by using field measurements. The test will measure net cooling capacity (tons of refrigeration) and energy requirements at the actual operating conditions. The objective of the test is to estimate the energy consumption at actual load vis-à-vis design conditions.

## HVAC and Heat transfer Loops in Refrigeration System

The Heating, Ventilation and Air Conditioning (HVAC) and refrigeration system transfers the heat energy from or to the products or building environment. Energy in form of electricity or heat is used to power mechanical equipment designed to transfer heat from a colder, low energy level to a warmer, high energy level. Refrigeration deals with the transfer of heat from a low temperature level at the heat source to a high temperature level at the heat sink by using a low boiling refrigerant.

There are several heat transfer loops in refrigeration system as shown in figure 1.

In Figure 1, thermal energy moves from left to right as it is extracted from the space and expelled into the outdoors through five loops of heat transfer.

**Indoor Air Loop:** In the leftmost loop, indoor air is driven by the supply air fan through a cooling coil, where it transfers its heat to chilled water. The cool air then cools the building space.

**Chilled Water Loop:** Driven by the chilled water pump, water returns from the cooling coil to the chiller's evaporator to be re-cooled.

**Refrigerant Loop:** Using a phase-change refrigerant, the chiller's compressor pumps heat from the chilled water to the condenser water.

**Condenser Water Loop:** Water absorbs heat from the chiller's condenser, and the condenser water pump sends it to the cooling tower.

**Cooling Tower Loop:** The cooling tower's fan drives air across an open flow of the hot condenser water, transferring the heat to the outdoors.

### Energy related Performance Terms

**Refrigeration:** Refrigeration is defined as an art of producing and maintaining the temperature in a space below atmospheric temperature.

**Tons of Refrigeration (TR):** One ton of refrigeration is the amount of cooling obtained by one ton of ice melting in one day: 3024 kCal/h, 12,000 Btu/h or 3.516 thermal kW.

**Energy Efficiency Ratio (EER):** Performance of smaller chillers and rooftop units is frequently measured in

EER rather than kW/ton. EER is calculated by dividing a chiller's cooling capacity (in Btu/h) by its power input (in watts) at full-load conditions. The higher the EER, the more efficient is the unit.

**Net Refrigerating Capacity:** A quantity defined as the mass flow rate of the evaporator water multiplied by the difference in enthalpy of water entering and leaving the cooler, expressed in kCal/h, tons of Refrigeration.

**kW/ton Rating:** Commonly referred to as efficiency, but actually power input to compressor motor divided by tons of cooling produced, or kilowatts per ton (kW/ton). Lower kW/ton indicates higher efficiency.

**Coefficient of Performance (COP):** Chiller efficiency measured in Btu output (cooling) divided by Btu input (electric power).

### Air-Conditioning Systems

Depending on applications, there are several options or combinations, which are available for use as given below:

- Air Conditioning (for comfort)
- Split air conditioners
- Fan coil units in a larger system
- Air handling units in a larger system

### Refrigeration Systems (for processes)

Small capacity modular units of direct expansion type similar to domestic refrigerators, small capacity refrigeration units.

Centralised chilled water plants with chilled water as a secondary coolant for temperature range over 5°C typically. They can also be used for ice bank formation.

Brine plants, which use brines as lower temperature, secondary coolant, for

typically, sub zero temperature applications, which come as modular unit capacities as well as large centralised plant capacities.

The plant capacities upto 50 TR are usually considered as small capacity, 50 – 250 TR as medium capacity and over 250 TR as large capacity units.

A large industry may have a bank of such units, often with common chilled water pumps, condenser water pumps, cooling towers, as an offsite utility.

The same industry may also have two or three levels of refrigeration and air conditioning such as:

Comfort air conditioning (20° – 25° C)

Chilled water system (8° – 10° C)

Brine system (sub-zero applications)

Two principle types of refrigeration plants found in industrial use are: Vapour Compression Refrigeration (VCR) and Vapour Absorption Refrigeration (VAR). VCR uses mechanical energy as the driving force for refrigeration, while VAR uses thermal energy as the driving force for refrigeration.

## Selection of Suitable Refrigeration System

A clear understanding of the cooling load to be met is the first and most important part of designing or selecting the components of a refrigeration system. Important factors to be considered in quantifying the load are the actual cooling need, heat (cool) leaks, and internal heat sources (from all heat generating equipment). Consideration should also be given to process changes and changes in ambient conditions that might affect the load in the future. Reducing the load, e.g. through better insulation, maintaining as high a cooling temperature as practical, etc. is the first step toward minimising electrical power required to meet refrigeration needs. With a quantitative understanding of the required temperatures and the maximum, minimum, and average expected cooling demands, selection of appropriate refrigeration system (single-stage or multi-stage, economised compression, compound or cascade operation, direct cooling or secondary

coolants) and equipment (type of refrigerant, compressor, evaporator, condenser, etc.) can be undertaken.

## Performance Assessment of Refrigeration Plants

- The cooling effect produced is quantified as tons of refrigeration (TR). 1 TR of refrigeration = 3024 kCal/hr heat rejected.
- The refrigeration TR is assessed as  $TR = Q \times C_p \times (T_i - T_o) / 3024$  where Q is mass flow rate of coolant in kg/hr  $C_p$  is coolant specific heat in kCal /kg deg C  $T_i$  is inlet, temperature of coolant to evaporator (chiller) in °C  $T_o$  is outlet temperature of coolant from evaporator (chiller) in °C. The above TR is also called as chiller tonnage.
- The specific power consumption kW/TR is a useful indicator of the performance of refrigeration system. By measuring refrigeration duty performed in TR and the kiloWatt inputs, kW/TR is used as a reference energy performance indicator.

## Performance Calculations

### Measurement of Compressor Power

The compressor power can be measured by a portable power analyser which would give reading directly in kW. If not, the ampere has to be measured by the available online ammeter or by using a tong tester. The power can then be calculated by assuming a power factor of 0.9  $Power (kW) = \sqrt{3} \times V \times I \times \cos\phi$

The energy efficiency of a chiller is commonly expressed in one of the three following ratios:

1. Coefficient of Performance

$$COP = \frac{\text{kW refrigeration effect}}{\text{kW input}}$$

2. Energy efficiency ration

$$EER = \frac{\text{Btu/h refrigeration effect}}{\text{Watt input}}$$

3. Power per Ton

$$kW/Ton = \frac{\text{kW input}}{\text{Tons refrigeration effect}}$$

### Performance Evaluation of Air Conditioning Systems

For centralised air conditioning systems, the air flow at the air handling unit (AHU) can be measured with an

anemometer. The dry bulb and wet bulb temperatures can be measured at the AHU inlet and outlet. The data can be used along with a psychrometric chart to determine the enthalpy (heat content of air at the AHU inlet and outlet).

Heat load can be calculated theoretically by estimating the various heat loads, both sensible and latent, in the air-conditioned room (refer standard air conditioning handbooks). The difference between these two indicates the losses by way of leakages, unwanted loads, heat ingress etc.

### Case Study: How to select Refrigeration Compressor Motor?

A reciprocating refrigeration compressor of a 100 TR is working at full load with 4.5 °C temperature difference across the evaporator. How to Estimate the water flow rate if water is secondary coolant? How to assess the connected motor size (Kw) to the refrigeration compressor?

Let us take the capacity of reciprocating compressor = 100 TR and working fluid is water so specific heat of water = 1 Kcal/Kg °c).

Chilled temperature across evaporator = 4.5 C.

So, Chilled water flow rate Q (kg/h) =  $(100 \times 3024) / (4.5 \times 1) = 67200 \text{ Kg/hr.}$

Specific power consumption of reciprocating compressor = 0.7-0.9 Kw/TR.

Hence, motor power =  $100 \times 0.9 = 90 \text{ Kw.}$

So, connected motor size may be 90 Kw or maximum 110 Kw may be selected.

### Energy Conservation and saving opportunities in refrigeration air conditioning plant area:

The following are few major energy savings opportunities in refrigeration plant area.

- Ensure adequate quantity of chilled water and condenser water flows, avoid by pass flows by closing valves of idle equipment.
- Minimise part load operations by matching loads and plant capacity online; adopt variable speed drives for varying process load.

- Make efforts to continuously optimise condenser and evaporator parameters for minimising specific energy consumption and maximising capacity.
- Ensure regular maintenance of all A/C plant components as per manufacturer guidelines.

## Other Energy Saving Opportunities

### Cold Insulation

Insulate all cold lines or vessels using economic insulation thickness to minimise heat gains; and choose appropriate (correct) insulation.

### Building Envelope

Optimise air conditioning volumes by measures such as use of false ceiling and segregation of critical areas for air conditioning by air curtains.

### Building Heat Loads Minimisation

Minimise the air conditioning loads by measures such as roof cooling, roof painting, efficient lighting, pre-cooling of fresh air by air-to-air heat exchangers, variable volume air system, optimal thermo-static setting of temperature of air-conditioned spaces, sun film applications, etc.

### Process Heat Loads Minimisation

Minimise process heat loads in terms of TR capacity as well as refrigeration level, i.e., temperature required, by way of:

- Flow optimisation
- Heat transfer area increase to accept

higher temperature coolant

- Avoiding wastages like heat gains, loss of chilled water, idle flows.
- Frequent cleaning or de-scaling of all heat exchangers

### At the Refrigeration A/C Plant Area

- Ensure regular maintenance of all A/C plant components as per manufacturer guidelines.
- Ensure adequate quantity of chilled water and cooling water flows, avoid bypass flows by closing valves of idle equipment.
- Minimise part load operations by matching loads and plant capacity on line; adopt variable speed drives for varying process load.
- Make efforts to continuously optimize condenser and evaporator parameters for minimizing specific energy consumption and maximizing capacity.
- Adopt VAR system where economics permit as a non-CFC solution.

## How Improved Energy Efficiency and 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.

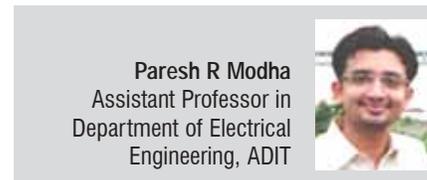
The benefits to the organisation realise themselves in terms of lower energy bills and improved energy efficiency with the potential to reduce costs by around 25-30 per cent per year compared to traditional or conventional HVAC systems.

## Methods by which IoT connected HVAC Systems can be made:

- With a WiFi Smart Thermostat
- Cloud Based Data Availability
- Real Time Monitoring and Control
- Local management on site.

## Conclusion

In this article, author has tried to explain the methods of energy performance assessment of HVAC and refrigeration systems. At this era, the labor cost, material cost and transportation cost are rising in India and worldwide. So, it is necessary to perform proper Energy conservation and audit. ■



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## “We focus on energy efficient and sustainable systems for HVAC”

**Dinesh Semwal, Managing Director, Ensavior Technologies** sheds light on working of thermal storage solutions, systems offered by Ensavior for Indoor Air Quality, technological innovations and many more in an email interaction with **Cooling India**.

### **Please take us through the journey of Ensavior.**

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

In less than ten years, Ensavior has been able to build its leadership position in the Indian HVAC industry and 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, gas phase filtration, automatic balancing and PICV, Stratified chilled water Thermal Energy Storage System, HVAC sensors / transducers and Electrostatic Precipitation System.

### **What exactly Stratified chilled water thermal storage does and how is it beneficial?**

Stratified chilled water storage system utilises natural stratification of the chilled water within the TES tank. The energy is stored in the form of chilled water. The naturally stratified TES tank is the main storage vessel and discharges the stored coldness for air-conditioning during on peak time. This operation scheme reduces the total energy consumption and operation cost.

Naturally, stratified chilled water thermal energy storage tanks are used as an integral part of a facility's air conditioning system, as well as for other applications. When used in large industrial facilities, on university or healthcare campuses, in district cooling projects, or on military bases, a chilled water TES system can save millions of dollars in lifecycle costs by reducing annual energy and operational costs. It helps in deferring capital

expenditures on equipment replacement of expansion projects. Further, it prevents downtime of mission critical operations. Moreover, a chilled water TES system improves the efficiency and power output of natural gas electrical power generators. It also acts as a negotiating tool in deregulated markets.

### **Air quality being talk of the town and a great concern these days, what Ensavior is doing about it?**

We have developed an advanced state-of-the-art air purification system that can be used as part of an air handling unit or as an independent side stream air purification which is a combination of Photo Catalytic Oxidation (PCO) and gas phase filtration with adequate controls and safety.

The multi-stage design allows for selection of the required filters in a specific sequence to meet the requirements of each application. The system removes gaseous pollutants, generates powerful oxidation and regenerates a bed of activated carbon.

It helps to achieve the desired high level of Indoor Air Quality by reducing VOCs, odours, contaminant gases. The UV radiation in PCO section penetrates micro-organisms such as fungi, bacteria and viruses and damages their DNA bonds, sterilising them. Apart from this, it greatly contributes towards achieving energy savings by optimising the usage of outdoor air.

### **What are the other solutions and services offered by the company keeping in mind rising global warming?**

Ensavior is offering the energy saving equipment systems or solutions like Pumping System, Hydronic Balancing Valves, Electrostatic Precipitation System and Ultra Violet Germicidal Irradiation (UVGI) Systems for the HVAC industry.

In Pumping System, we offer a wide range of pumps (both constant speed and variable speed) for applications such as HVAC and Firefighting. We also have skid mounted systems along with their controllers, thereby, offering a complete solution. We believe in taking the job from the intent of providing a comprehensive engineering solution rather than mere equipment selling.

An effective and efficient HVAC system must provide correct energy output, when and where required. Water circuit balancing is essential to ensure that chilled water system delivers correct flows to all terminal units in an HVAC circuit. Proper hydronic balancing is the key to making an HVAC system perform efficiently and cost-effectively. To cater to this critical feature, we are offering PICV and Automatic Balancing Valves.

Electrostatic precipitation systems are used for removal of grease and smoke from commercial kitchens and also smoke, fumes and oil or coolant mist from industrial processes. It is a proven electrostatic precipitation technique to remove smoke, grease, mist and other particulates from the air to keep the outdoor air safe, healthy and pollution-free.

Ultra Violet Germicidal Irradiation (UVGI) System uses the ultraviolet energy to kill or inactivate microbes (viral, bacterial, fungal species) from forming on the cooling coils of the air handling unit and thus, eliminating the possibility of unwanted unhealthy contaminants within the air-conditioned space.

### **What are the growth drivers of your business?**

Ensavior has its growth strategy in place where we focus on energy efficient and sustainable systems for the HVAC and related sectors. This strategy also looks at increasing the base business and penetration into tier-II cities. We are also geared up to cater to the HVAC aftermarket services. We have come a long way, delivering reliable products and services to our customers. In return, we have gained their trust and repeat orders. In our journey so far, we have thrived financially and continue to invest in our brand awareness.

### **Please elaborate on the latest technological innovations incorporated in your product.**

All our range of products are uniquely unconventional and offer great benefits and various applications in the industry, specially, HVAC. We have been innovative enough to advance our products to cope up with the changing needs of the environment as well as industry.

FlowCon Energy FIT System, is the latest innovative product which is the world's first pressure and temperature independent regulation valve. FIT System provides monitoring, measuring, connectivity and control in one package including PICV valve, sensor kit and the new FlowCon Intelligent Interface.



**We have developed an advanced state-of-the-art air purification system that can be used as part of an air handling unit or as an independent side stream air purification which is a combination of Photo Catalytic Oxidation (PCO) and gas phase filtration with adequate controls and safety.**

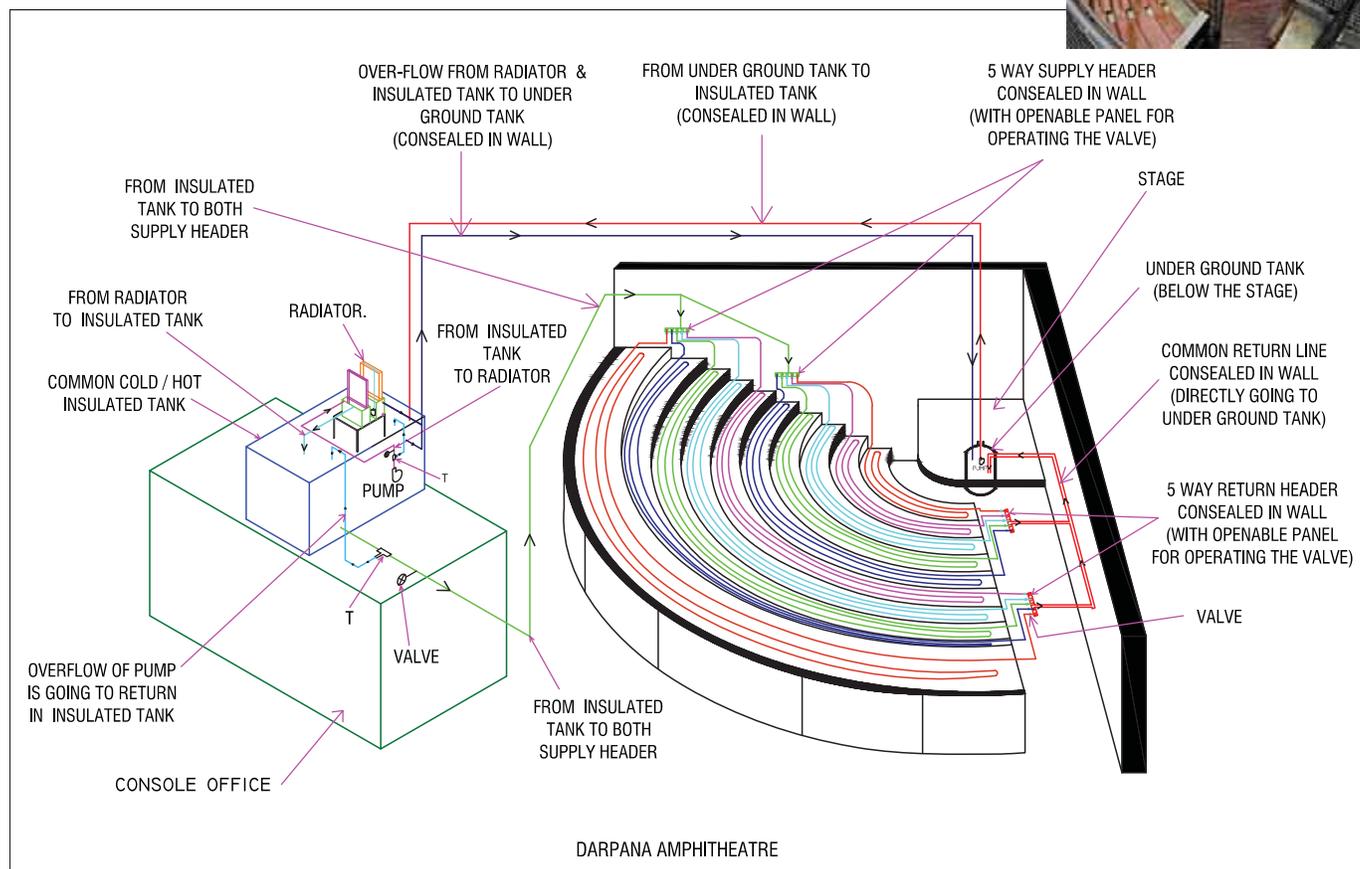
The FIT System measures energy usage while monitoring coil performance and adjusts the PICV to optimise coil performance. The PICV maintains the correct flow, despite pressure changes, and guarantees that flow will change only when demand requirements change or temperature difference is outside specification.

### **What is your outlook for HVACR industry?**

Growth in Metro rail network, data centers, retail, hospitality and commercial sectors is significantly boosting the demand for HVAC systems in the country, as these sectors involve large scale application of HVAC systems in organised retail outlets, shopping complexes, hotels, etc. High-rise buildings, shopping complexes, malls, hypermarkets are now penetrating in tier-II Cities as well contributing to the growth of HVAC business. ■

# Natural Cooling of Amphitheater Using Indian Heritage Techniques

Panasia Engineers has developed 'ThermOdrain'. It drains the solar heat out of the structure to keep it cool. It is a 'passive' system because the heat always travels from high to low temperature, never from low to high.



Like so many people and organisations working for solutions to global warming, we at Panasia Engineers are also active in the thermal comfort area. We have developed 'ThermOdrain'. As the name suggests, it drains the solar heat out of the structure to keep it cool, just as a roof drains out the rain to keep the interior dry. It is a 'passive' system because the heat always travels from high to low temperature, never from

low to high. Thus, it does not need any energy.

The Natrani project, it is a 385-seat open air Amphitheatre owned by Darpana Dance Academy of Mallika Sarabhai. It is located on the riverfront at Ahmedabad

The problem was – how to provide thermal comfort and cool fresh air in an affordable eco- friendly manner.

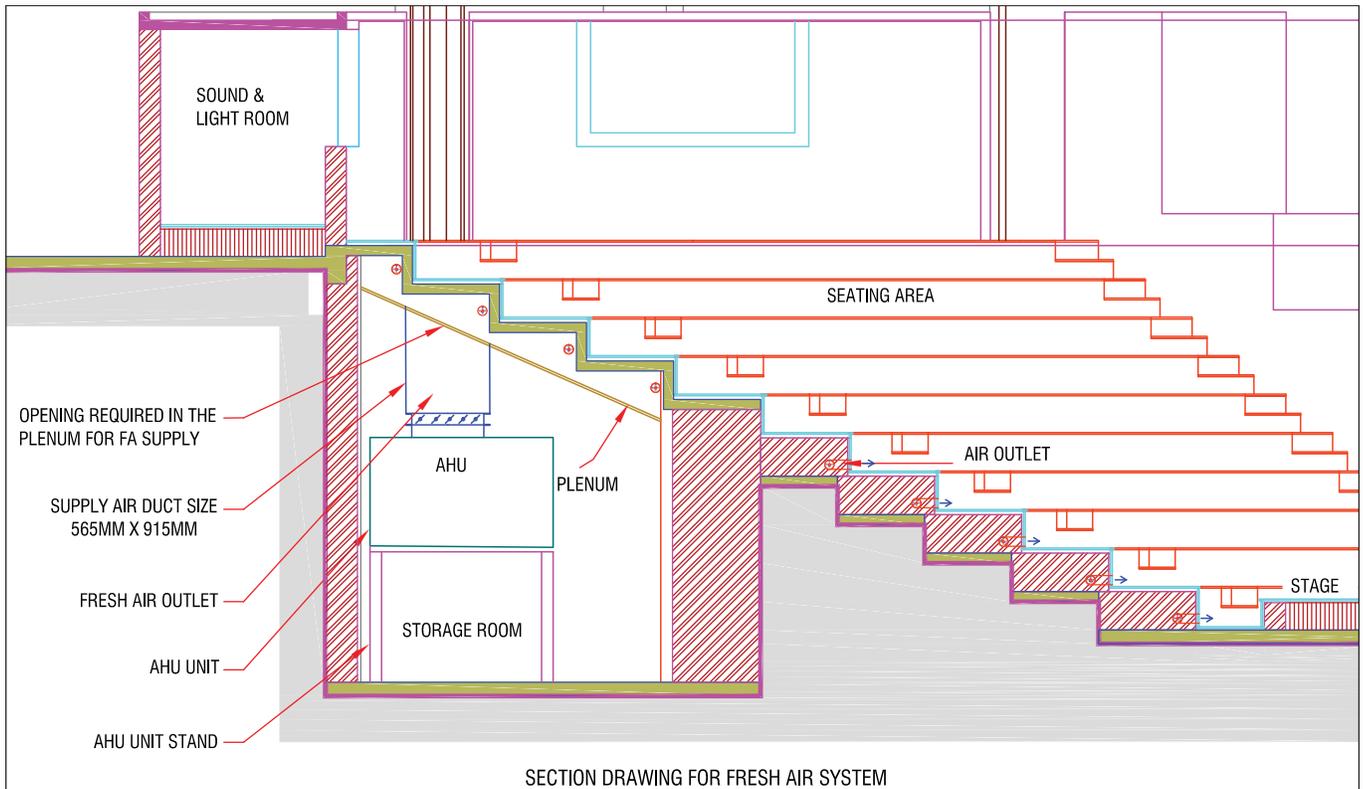
Since air conditioning, evaporative cooling or high-volume ventilation options

were not feasible, natural cooling was chosen. There are two parts – structure cooling and gentle displacement ventilation.

## Structure Cooling

Structure Cooling starts with a 1.6 lakh liter rainwater harvesting tank under the stage. Water from here is pumped up to a high-level tank and a radiator unit.

After getting cooled by the radiator, the



SECTION DRAWING FOR FRESH AIR SYSTEM  
Diagram 2: Working of structure cooling.

water drains by gravity back to the underground tank through plastic pipes laid under the tiers in a serpentine loop. The pipes are then covered by screed.

In operation, the water in the pipes absorbs the heat from the structure and keeps it below the body temperature, thus providing comfortable seating.

The layout of structure cooling is shown in diagram 1.

### Displacement Ventilation System

An AHU with a fan and filter draws air from outside and pumps it into a plenum under the steps. From there, it enters gently into the arena through a number of 70 mm holes, covered by grilles, through the steps.

The air is cooled by contact with the

cool structure, as per our Hawa Mahal tradition, and lightly displaces stale humid air, thus freshening the surroundings.

Diagram 2 shows the working of structure cooling.

### Proof of the Pudding

Temperature readings were taken on the day of the opening. Refer Table 1.

The ambient temperature was 45Deg.C Max.

Thus, the green room and the seats were below human skin temperature and therefore, comfortable.

- Electrical power figurers are as under
1. Cooling system- Total one kilowatt including pumps and radiator fan.
  2. Ventilation AHU – Two Kilowatts for 6000 CFM

### Comment from a Spectator Present at the first Show

It was indeed a great experience. September 21, was a hot day, but even then, the seat at Natrani was a very good comfortable feel. Always, since years we, all members on Natrani, have been sitting on the burning hot to really cold polished kotah stone seats and enjoying performances at the beautiful amphitheatre, but this time at the unveiling and reopening of Natrani, we were seated on controlled temperature red mosaic seats and it was a wonderful feel.

Engineering used at it is the best for the maximum comfort of the user. The vents on risers of the steps at regular intervals, gave cool thrust of air and added

Table 1: Temperature readings were taken on the day of the opening at Natarani Amphitheater - September 2018

Date	Time	Ambient temperature in Green Room	Surphase temperature below seating	External temperature at location 1 (shaded area only)	External temperature at location 2 (shaded area only)	External temperature at location 3 (shaded area only)
16 - 9 - 2018	11:00	30.2	31.6	36.2	35.2	33.8
	5:00	31.2	31	37.8	38.6	34.2
17 - 9 - 2018	11:00	30.2	31.6	37.2	37.6	35
	5:00	31.2	31	34.8	35.4	35.2
18 - 9 - 2018	10:00					

**The Radiator**



- The radiator is the key element in the ThermOdrain System
- It has two sections.
- The main section comprises a passive cooling coil (No refrigeration) and a fan.
- The other section has an evaporative cooling pad, used when the ambient temperatures are high, to cool the air going through the radiator.
- Together they dump the heat out.

marginally trained persons can understand and apply to provide 'Adaptive' thermal comfort.

- It is universally applicable in any country between the two tropics, regardless of the weather.
- Two Masters' and one PhD Theses confirm that it meets "Adaptive Cooling" Criteria.
- It is quite affordable to own and the running and maintenance cost is negligible.
- It can be retrofitted in most cases, particularly, the roofs.
- While the name "ThermOdrain" is a Trademark, the technology itself is not patented or copyright protected.

to the cooling.

**Way Ahead**

From very humble beginnings, the HVAC industry has grown into a Behemoth that is gobbling away at our energy resources while degrading our environment. While the industrial segment justifies itself, the domestic and commercial thermal comfort division drains away the energy, only for a few degrees of cooling. So far, almost every proposed alternative solution is either complex or costly or both.

A simple solution has been staring at us all the while. Taj Mahal and heritage

buildings that remain cool without using any machinery or energy.

Their technique of using massive structures to absorb heat is no longer practical. So, we have modified it to use water instead. That is the method used here and the results are here for all.

ThermOdrain can be the slingshot because

- It is a very simple technology that even

We shall gladly share it with anyone that can qualify for it without any charge.

We hope ThermOdrain will be universally adopted, provide jobs to millions of low tech persons and reverse global warming. ■



**Uday Andhare**  
Design Principal  
Indigo Architects  
Ahmedabad



**Surendra H Shah**  
BE Mechanical Engg,  
Clemson University, USA  
Founder & Owner of  
Panasia Engineers Pvt Ltd,  
Mumbai

# Carel Group Acquires 100% Of HygroMatik GMBHR

The acquisition by Carel Industries SpA of the entire share capital of HygroMatik GmbH (part of the group Spirax Sarco Engineering PLC) has been completed. The company is based in Henstedt-Ulzburg, near Hamburg. It designs, produces and markets humidifiers and related accessories, in the industrial, commercial and wellness field.

The transaction is an implementation of one of the main pillars of the Group's strategy, which envisages a growth path through M&A activities aiming to strengthen its core business, increasing market share in the reference geographical areas and in contiguous applications.

Indeed, integration with HygroMatik will consolidate Carel's positioning in German-speaking countries and in northern Europe thanks to the strong penetration of the acquired company in these markets and will allow for a better positioning in the context of different applications, leveraging the strength of the brand, the industrial

excellence and specialised expertise in the field of humidification of one of the main players in the sector. To this will be added the contribution of the exclusive technological, strategic and commercial know-how that Carel has developed during its 45 years of life and that will be the basis for exploiting further growth opportunities.



Group CEO Francesco Nalini, said, "The HygroMatik GmbH transaction follows the acquisition of Recuperator SpA completed on 23 November and confirms Carel's focus on M&A activity as a strategic lever, which, together with organic growth, will be a driver of our development in the coming years. In particular, the integration with

HygroMatik, one of the most dynamic and innovative companies in the sector, will allow the Group to improve its positioning on the German and Northern European markets, strengthening its European leadership in reference applications." ■

# Energy Efficient Fans for Refrigerated Cabinets

**ebm-papst** offers efficient fan concepts for applications for both medium and low temperature refrigeration systems

The fans used in refrigerated display cases and bottle coolers in the commercial food sector have very long operating times. They offer great potential for saving energy. ebm-papst offers efficient fan concepts for applications for both medium and low temperature refrigeration systems.

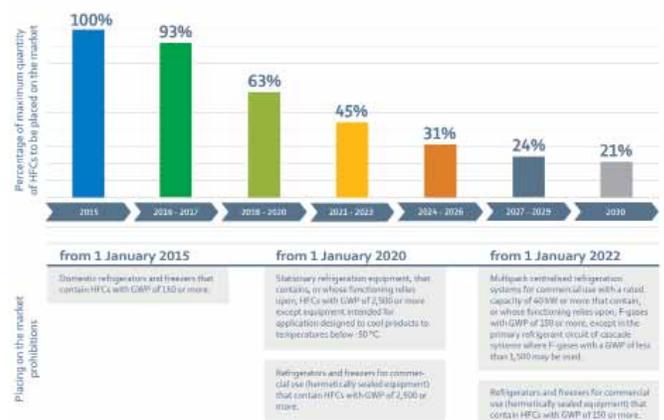
## The right fan for every application

For installation in refrigeration and freezing applications, ebm-papst provides modern fan concepts based on an extremely efficient, electronically commuted EC motor. Among the range of several energy-efficient motor variants, the energy-saving motor (ESM) is predestined for use in refrigerated cabinets. With an efficiency level of up to 70 per cent, it consumes only one third of the power of a comparable shaded-pole motor. The compact EC motors are available both as OEM components for combining with a separate impeller and as complete plug and play systems. Whereas the axial series is designed for installation under shelves, the fans with a diagonal impeller are designed to be installed in the rear panel of refrigerated display cases. Thanks to their extremely flat design, these fans fit in confined spaces and they are well equipped to deal with the higher back pressure encountered in such situations. ebm-papst also provides the energy-saving NiQ motor for the sustainable conversion of relatively old refrigerated cabinets. It is mechanically compatible with existing shaded-pole motors and makes 1:1 replacement easy thanks to the identical installation dimensions.



Energy-saving motor (ESM) for installation in refrigeration & freezing applications under shelves – energy saving and with speed control

## Regulation (EU) No 517/2014 on fluorinated greenhouse gases



“Fluorinated gases – Prohibitions on placement on the market”

## Does it really have to be ATEX?

A further major issue with regard to refrigerated cabinets is the refrigerant used. Directive (EU) 517/2014, also known as the Fluorinated Gas Directive, has been in force since January 1, 2015. Alongside ammonia and CO<sub>2</sub>, natural refrigerants such as isobutane, propane, and propene are becoming increasingly popular as an ecological alternative to (partially) halogenated refrigerants. When malfunctions occur, however, the non-toxic hydrocarbons can form readily explosive mixtures with air.

The motors and complete systems from ebm-papst satisfy the requirements of the European standard EN 60335-2-89 (household appliance standard – Particular requirements for commercial refrigerating appliances) as standard and can safely be used for cooling solutions in this sector. This is fully adequate for the majority of refrigerated display cases, as their cooling circuits work with the 150 g maximum refrigerant quantity required by the standard. In the case of high-capacity refrigeration circuits, it may be useful to split the circuits. If that is not possible, ebm-papst offers fans with an energy-saving motor in accordance with ATEX approval II 3G Ex nA IIA T4 Gc for refrigerant quantities exceeding 150 g. These fans comply with ATEX standard EN 60079 and are therefore also approved for use in large refrigerated display cases as well as composite and cascade systems using more than 150 g of flammable refrigerant. ■

# Design of Cold Storage for Fruits & Vegetables

Having cooling and storage facilities makes it unnecessary to market the produce immediately after harvest. This can be an advantage to growers.



Photo Credit: www.srisoonvegetable.com

Cold storage is the one widely practiced method for bulk handling of the perishables between production and marketing process. 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.

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 helping maintain 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 to 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/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 things, which do not show incompatibility 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 incompatible 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:**

1. Most perishable products, not sensitive to cold (0-4°C)  
e.g. Apple, grape, carrot and onion
2. Vegetable produce moderately sensitive to cold (4-8°C)  
e.g. Mango, orange, potato and tomato (ripened)
3. Vegetable produce sensitive to cold (>8°C)  
e.g. Pineapple, banana, pumpkin and bhendi

**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, chillies, 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, flavor and texture changes.

The general features of a cold store operational program (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. 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 is the 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

Table: Heat removed in cooling air storage room conditions (BTU per Cu. ft)

°F		Temperature of Outside Air											
		40°F. (4.4°C.)		50°F. (10°C.)		85°F. (29.4°C.)		90°F. (32.2°C.)		95°F. (35°C.)		100°F. (37.8°C.)	
		Relative Humidity of Outside Air, %											
°F	°C	70	80	70	80	50	60	50	60	50	60	50	60
55	12.8					1.12	1.34	1.41	1.66	1.72	2.01	2.06	2.44
50	10.0					1.32	1.54	1.62	1.87	1.93	2.22	2.28	2.65
45	7.2					1.50	1.73	1.80	2.06	2.12	2.42	2.47	2.85
40	4.4					1.69	1.92	2.00	2.26	2.31	2.62	2.67	3.65
35	1.7			0.36	0.41	1.86	2.09	2.17	2.43	2.49	2.79	2.85	3.24
30	-1.1	0.24	0.29	0.58	0.66	2.00	2.24	2.26	2.53	2.64	2.94	2.95	3.35
25	-3.9	0.41	0.45	0.75	0.83	2.09	2.42	2.44	2.71	2.79	3.16	3.14	3.54
20	-6.7	0.56	0.61	0.91	0.99	2.27	2.61	2.62	2.90	2.97	3.35	3.35	3.73
15	-9.4	0.71	0.75	1.06	1.14	2.45	2.74	2.80	3.07	3.16	3.54	3.51	3.92
10	-12.2	0.85	0.89	1.19	1.27	2.57	2.87	2.93	3.20	3.29	3.66	3.64	4.04
5	-15.0	0.98	1.03	1.34	1.42	2.76	3.07	3.12	3.40	3.48	3.87	3.84	4.27
0	-17.8	1.12	1.17	1.48	1.56	2.92	3.23	3.28	3.56	3.64	4.03	4.01	4.43
-5	-20.6	1.23	1.28	1.59	1.67	3.04	3.36	3.41	3.69	3.78	4.18	4.15	4.57

Source: ASHRAE 1967 Handbook of Fundamentals

the average of the extent of occupation during a given period — usually a year, but it can also be per month.

The earlier cold storages were cubical in shape in order to minimise 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.

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:

- **Transmission Load:** Heat entering through the insulated walls, ceiling, and floor. This heat gain is directly



View of fruit and vegetable storage in C A Store near Mohali (Punjab)



Layout of pack-house and related equipments required

proportional to the Temperature Difference (T.D.) between the two sides of the wall. The type and thickness of insulation used in the wall construction, the outside area of the wall and the T.D. between the two sides of the wall are the three factors that establish the wall load.

- **Air Change Load:** When the door to a refrigerated room is opened, warm outside air will enter the room. This air must be cooled to the refrigerated room temperature, resulting in an appreciable source of heat gain. This load is sometimes called the infiltration load. The probable number of air changes per day and the heat that must be removed from each cubic foot of the infiltrated air.

**Field Heat:** Whenever a product having a higher temperature is placed in a refrigerator or freezer room, the product will lose its heat until it reaches the storage temperature. This heat load consists of separate components:

**Specific Heat:** The amount of heat that must be removed from one pound of product to reduce the temperature of this pound by 1°F, is called its specific heat. It has two values: one applies when the product is above freezing; the second is applicable after the product has reached its freezing point.

**Latent Heat:** The amount of heat that must be removed from one pound of product to freeze this pound is called the latent heat of fusion.

Estimating specific and latent heats:

Sp. Ht. above freezing =  $0.20 + (0.008 \times \% \text{ water})$

Sp. Ht. below freezing =  $0.20 + (0.008 \times \% \text{ water})$

Latent Heat =  $143.3 \times \% \text{ water}$

**Pull down Time:** When a product load is to be calculated at other than a 24 hour pull down, a correction factor must be multiplied to the product load. The hourly heat load serves as the guide in selecting equipment. It is found by dividing the final BTU/24 hour load by the desired condensing unit run time.

- **Heat of Respiration:** Heat generated by the produce as a natural by-product of its respiration. Fresh fruits and vegetables are alive. Even in refrigerated storage they generate heat which is called the heat of respiration. They continually undergo a change in which energy is released in the form of heat, which varies with the type and temperature of the product.
- **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



View of cool recovery system during air exchange and proper handling at cold store

temperature with consideration being given to a proper balance between initial, operating, maintenance, and depreciation costs. As per the directions of the MIDH, the projects shall be recommended as per the following component wise cost.

Item	% of the project cost (range)
Civil construction	50 – 55
Thermal insulation	10 – 15
Refrigeration system	20 – 25
Electrical system	10 – 15

The basic procedures for construction of the cold store units should have the following requirements:

### a) 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.

### b) Planning Drawings & 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.

### c) Design Drawings & 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





Few additions like air curtain, strong pallet & pre-cooling facility that improve the quality of stored products

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. 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. 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. One can consult local power company for details. In addition, it is a good idea to anticipate any future growth when locating and designing any facility. 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:

- Nature of the products
- Frequency of loading and unloading
- Calendar for harvest and dispatch
- Field heat of the produce
- Daily tonnage of produce to be handled
- Daily tonnage of ice to be manufactured
- Nature and dimension of packages

Availability of skilled and unskilled labor from the local area is the major factor to be considered for the successful operation.

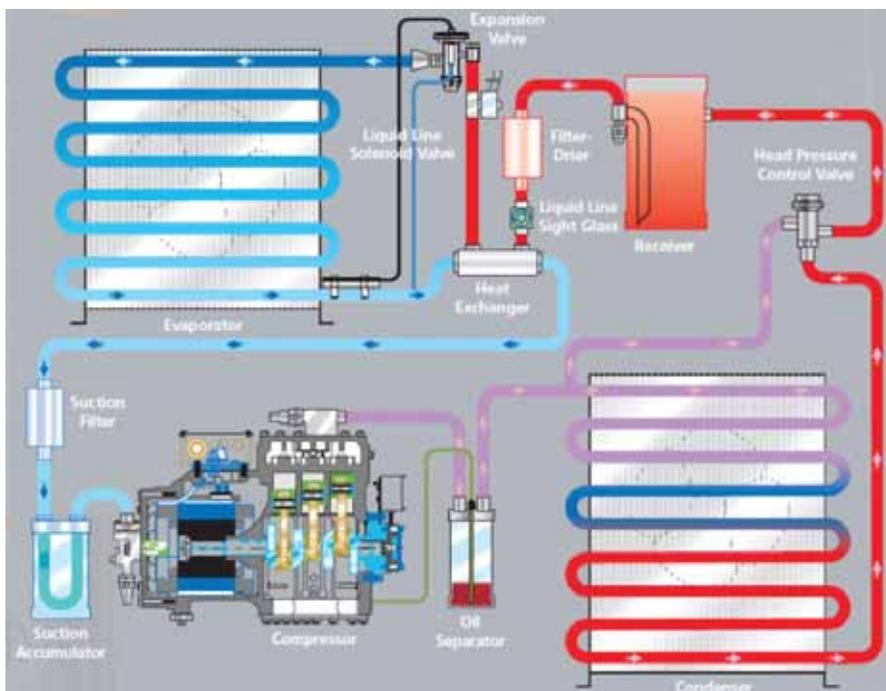
## Equipment Selection

When the hourly BTU load has been determined, equipment can now be selected. Some of the factors affecting equipment selection are:

- Equipment Balance
- Temperature Difference (TD)
- Capacity Control or Product Safety
- Type of Operation or Air Flow

## Equipment Balance

The condensing unit is generally selected first to have capacity greater than the calculated cooling or freezing load. The unit cooler(s) must be selected to balance the capacity of the condensing unit. The



Schematic description of refrigeration system in a typical cold store.

### Recommended Temperature Differences (TD) for Four Classes of Foods (Forced Air Unit Coolers)

Class	T. D.	Approx RH	Description of Product Classes
1	7-9 °F	90%	Results in a minimum amount of moisture evaporation during storage. Includes vegetables, product, flowers, unpacked ice and chill rooms
2	10-12°F	80-85%	Includes general storage and convenience store coolers, packed meats and vegetables, fruits and similar products. Products require slightly lower relative humidity levels than those in Class I.
3	12-16°F	65-80%	Includes beer, wine, pharmaceuticals, potatoes and onions, tough skin fruits such as melons and short term packaged products. These products require only moderate relative humidity
4	17-22°F	50-65%	Includes prep and cutting rooms, beer warehouses, candy or film storage and loading docks. These applications need only low relative humidities or are unaffected by humidity.

### Recommended Air Changes/Hour

Type of Application	Recommended Number of Air Changes	
	Minimum	Maximum
Holding freezer	40	80
Packaged Holding Center	40	80
Cutting Room	20	30
Meat Chill Room	80	120
Boxed Banana Ripening	120	200
Vegetables and Fruit Storage	30	60
Blast Freezer	150	300
Work Areas	20	30
Unpackaged Meat Storage	30	60

capacity of the condensing unit should be selected at a suction temperature (after correction for suction line pressure drop) which will balance with the unit cooler(s) at a desirable TD between the refrigerant in the unit cooler and the air in the refrigerated storage room. The condensing unit capacity must also be selected at a condensing temperature corresponding to the condensing medium (ambient air or water) temperature available at the job location.

### Temperature Difference

(For Storage Rooms Above 32°F (0°C.)

The nature of the product determines the desirable relative humidity for the storage room. The desirable relative humidity, in turn, dictates the approximate design TD between the air in storage room and the refrigerant in the unit cooler. For the general purpose, cooler involving meats, vegetables, and dairy products, it is common procedure to balance the low side to the condensing unit at a 10°F to 12°F. TD. It has been learned by experience that if this is done, one may expect to maintain in a cooler 80 per cent to 85 per cent relative humidity, which is a good range for general storage. TDs can be

approximated by dividing the unit cooler capacity at a 1° TD into the condensing unit capacity at the desired saturated suction temperature (SST). In low temperature rooms, the amount of dehydration of unwrapped products is proportional to the TD. Since the prevention of excess dehydration is important and since low temperature condensing unit capacities drop off sharply as the suction temperature reduced, it is considered good practice to use a maximum TD of 10°F.

### Product Safety or Capacity Control

In large boxes, it is recommended that the load be divided among multiple units. A load that requires more than a 10 HP unit should be split to provide the customer with some refrigeration level in the event of mechanical failure. In addition, as refrigeration is selected for the 1 per cent worst occurrence of the year, multiple

units provide for some capacity control. In low load situations, some units can be turned off and the box maintained adequately with a fraction of the horsepower necessary for the summer operation. Multiple units on staged start up also cut the demand charges assessed by the utility company which cut your customer's electric bill.

### Type of Operation or Air Flow

Two important considerations in the selection and location of the unit cooler are uniform air distribution and air velocities which are compatible with the particular application. The direction of the air and air throw should be such that there is movement of air where there is a heat gain; this applies to the room walls and ceiling as well as the product. The unit cooler(s) should be arranged to direct its discharge air at any doors or openings, if it all possible. Avoid placing the unit cooler in a position close to a door where it may induce additional infiltration into the room; this can cause fan icing and a condition known as hoar-frost. Also, avoid placing a unit in the air stream of another unit, because defrosting difficulties can result.

For general storage coolers and holding freezers, there are not criteria for air velocities within the room. The total supply of air is such that approximately 40 to 80 air changes occur each hour.

$$\text{Air Changes} = \frac{(\text{total cfm}^*) \times 60}{\text{internal room value}}$$

\*includes all unit coolers and auxiliary fans ■

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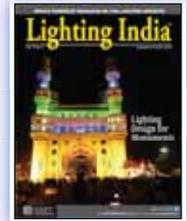
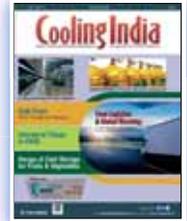
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# Energy Efficient Cold Chain Logistics using Phase Change Material (PCM)

Using passive cooling materials i.e. phase change materials (PCM), as thermal energy storage (TES) media, enables transportation of goods at a constant temperature.



Photo Credit: www.arctic-solutions.in

India is an agriculture-based economy with more than 55 per cent of the land being cultivable as compared to the global average of 11 per cent. However, due to a poorly integrated agro-supply chain industry that poses multiple challenges at each step of operation, there are huge gaps in the terms of capacity and integration of the cold chain supply

system. According to Ken Research reports, the Indian cold storage capacity has grown only 20 per cent during 2012 to 2017 and its cold chain logistics market is estimated to grow at a compound annual growth rate of 27 per cent. This is expected to expand at an annual growth rate of 23.88 per cent in terms of value by 2019 end. With the awareness towards supply

chain of temperature-sensitive products, there has been a dramatic improvement in transportation facilities and storage mechanisms. This unique technology has enabled longevity in the shelf life of these consumable products and retains their quality up to the last mile.

However, logistic solutions based on refrigerated vehicles are dependent on



Figure 1: PCM filled thermoTab active plates being used in reefer trucks for last mile delivery of temperature-sensitive food products.

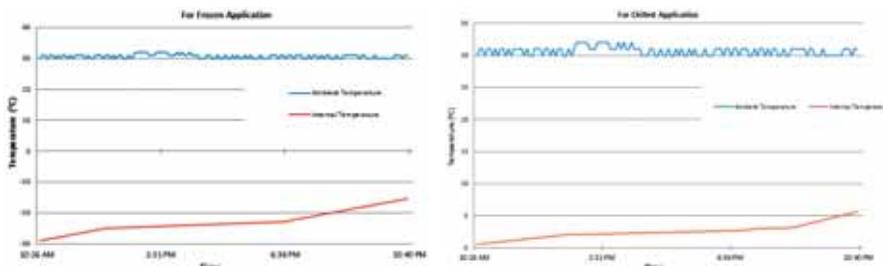


Figure 2: Temperature-performance graphs of thermoTab active based reefer trucks.

fossil fuels. As an outcome, the cost of the logistics solutions is twice as that of general commodities. The shift from conventional trucks dependent on diesel-run refrigerated systems to non-diesel based refrigerated systems has a huge potential in bringing down the costs in an affordable range. Using passive cooling materials i.e. phase change materials (PCM), as thermal energy storage (TES) media, enables transportation of goods at a constant temperature. Refrigerated trucks lined with PCM panels are charged through active cooling while the truck is idle. Once charged, the temperature of the container is maintained in the desired range with zero consumption of diesel. Different PCM based logistics solution caters to different applications and temperature with its unique formulations. PCM ranging from -30oC to -10oC is suitable to suffice cooling requirements of products like meat, frozen food, fresh vegetables, ice creams and similar. PCM ranging from -10 to 50C provides a

suitable environment for chilled products i.e.dairy products (like milk, yogurt etc..) and beverages. Integrating suitable temperature PCM to meet the transportation requirements of sensitive goods has a significant impact on diesel consumption. The diesel requirement cuts down to more than 50 per cent along with precise temperature control by implementing the TES system.

### Case Study

The advantage of using this system can be easily understood by going through an example of its usage in an 8 feet container truck (let's say, a TATA 407 reefer truck). If we compare a PCM integrated truck with a conventional diesel operated reefer truck, the savings on its running cost are phenomenal. Such a system is charged (or freezing the PCM below its phase change temperature) during the non-operational hours using grid-power supply, there is complete saving on the diesel cost which in the

other case of conventional reefer truck is needed continuously for temperature maintenance inside the insulated container. The cost of operation through diesel, in comparison to electric power for cooling, is almost two times. Owing to this great advantage, thermoTab active based reefer trucks have a very short payback period of fewer than six months, in spite of having a little higher initial investment cost involvement. Apart from savings on running cost, it also ensures that the system remains intact and long-lasting due to non-moving parts and components. Compared to a conventional system, this technology also ensures that the perishables and temperature sensitive consumer products are safe even in a situation where the truck breakdowns and no alternative provision for active cooling is present. A face to face comparison of this system with the conventional reefer truck systems is shown in Table 1.

The graphs in figure 2 clearly demonstrates that for an ambient temperature rising more than 30oC, the PCM filled thermoTab active plates maintain the temperature of the product for more than 12 hours of operation. Therefore, it will be safe to conclude that the temperature-sensitive products under the safeguard of this passive cooling technique will not suffer any damage or wastage.

### Conclusion

The following are the benefits of using the passive cooling techniques instead of a conventional Diesel-run reefer truck.

- Lower dependency on the Fossil Fuel.
- Ensures temperature maintenance for temperature-sensitive products even during truck breakage
- Lower operating cost.
- Lower maintenance cost.
- Quick to charge.
- Green Energy. ■

Table 1: Comparison between TES based Passive cooling system and Diesel based conventional cooling system

TES Based System	Conventional Cooling System
No dependency on fossil fuels; use of solar energy or grid power to charge once a day.	Fully dependent on fossil fuel or diesel for drawing continuous power.
Low servicing and operating cost – 30-40 per cent lower than a conventional system	Higher servicing and operating cost involved in full load logistics
Shelf life ~ 10 years.	Shelf life ~ five years (due to continuous moving parts involved)
No skilled personnel required for its operation	Skilled personnel required for its servicing and constant observation
The product is continuously cooled even if the truck breaks down during the cold chain transportation	Product safety hampered if truck or compressor breaks down during its transportation
Non-polluting – green product as no exhaust generated	Air pollution due to continuous exhaust generation while cooling reefer truck containers

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# Achieving Energy Savings & High Efficiency for Odisha Ice Cream Plant

The case study highlights improvement in plant efficiency and safety of Ammonia Refrigeration System at a modern technology ice cream manufacturing unit at Cuttack near Bhubaneswar, Odisha.

This is a case study on improving plant efficiency and safety of Ammonia Refrigeration System at a modern technology ice cream manufacturing unit. The plant is located at Cuttack near Bhubaneswar, Odisha. The production capacity of the facility is 10 MT of ice cream every day for meeting the market requirements of Odisha and the neighbouring states.

The directive from the owner was to upgrade in phases the existing refrigeration plant for higher efficiency and safety, involving reasonable investments. Many a time plant upgrade or modernisation leads to complete change of plant whereby heavy investment and payback estimated at 3 to 4 years are estimated. Hence, it was decided that plant improvement should be based on green design aiming to achieve the highest efficiency and safety management plan. The objective was to keep ROI period less than a year apart from achieving minimum 15 per cent energy savings. The refrigerant used for plant is pure Ammonia (earns high environmental marks with ODP & GWP being Zero) which breaks down to its natural components of nitrogen and hydrogen in a relatively short time. The facilities' refrigerating system is operated through natural (gravity) flooded feed.

## Noted Prevailing Problems

A systematic study was conducted accordingly to implement the above. The primary step was to prepare a HAZOP report

and investigate operational plant problems on day-to-day basis. We proceeded by recording plant operation parameters and operating hours. After careful study, following problems were observed in the existing refrigerating system:

- The chiller rooms and freezer rooms are not able to achieve the desired temperature in spite of long running hours of compressors.
- All unit compressors including standby were required to remain in operation in order to meet the required refrigeration capacity.
- The compressors were running full load at all times.
- The compressor suction pressure and plant evaporating temperatures did not correlate. The suction pressure was much lower than the corresponding room temperature.
- The compressor discharge pressure was high considering the ambient conditions.
- Complete plant had to be operated manually.
- The air cooler coils for chiller (cold) rooms and freezer rooms were frosted.
- Although the cold room and freezer rooms were designed at -25°C room temperature, the best temperature achieved would be below -14°C.
- The defrosting system was manual and was never able to defrost the coils completely.
- Plenty of oil was getting accumulated

in ACU or Freezer coils.

- Plant safety management was non-existent.
- The level control system was bypassed and operators were manually throttling the valves on receiver supply line.
- Freezer air cooler coils were starved for liquid supply, but operators were afraid of liquid surge to compressor.
- Operators were kept occupied by operating various valves and using all efforts to check operation, temperature and liquid level.
- Due to small leakages through flange joints, strong ammonia odour was continuously felt in the machine room.
- The chiller rooms and freezer rooms were located around the plant and many times the loader would be trapped in the room, thus, preventing the trapped person to freely communicate with plant operators.

## Energy-Efficient Measures & Novel Solutions

These conditions lead to high energy consumption and loss of production while overall plant was unable to perform at designated requirement. While considering above conditions, the allocated budget to rectify the above conditions was quite limited and in view of time constrain, it was decided to concentrate on achieving desired room temperature, increase plant efficiency and improve plant safety at the shortest period of time.



Plant discharge pressure before plant modification



Plant discharge pressure after plant modification



Fully automatic air purger in operation



Ammonia Leak detection system



Cold Room Safety



Plant piping after modification

Another constraint was lack of highly skilled and certified manpower for operation of the plant. Hence, it was required to provide an automatic operating system which can be easily handled by professional plant operators. The following functions were performed to update plant operation, smoothly and trouble-free:

- Installation of dual safety (relief) valves on all pressure vessels with required pressure ratings.
- Calibrated compressor safety cut out, repaired and reconnected for safety.
- Installed (on each compressor) easy to use Automatic Compressor control system with energy monitoring.
- Installation of fully automatic air purger on condenser and liquid receiver circuit.
- Installation of automatic hot gas defrosting system (replacing the existing manual defrost) on all air cooling units in chiller

rooms and freezer rooms.

- Installation of temperature monitoring and control devices for all cold rooms and freezer rooms.
- The automatic level control system was serviced and put into use.
- Installation of the reflex type level gauges and removed the glass tube one.
- Installation of an integrated automatic ammonia leak detection system.
- Replacement of all flange type valves with 40 bar weld in-line valves. The valves were chosen with back seating facility.
- The chiller room alarm system with built-in battery back-up was installed on machine room doors for trapped loader and generate alarm in plant room. This unit was incorporated with inbuilt battery backup so that it can work independently in the event of power outage.



Easy to use compressor automation system



Data monitoring system with webbased operation and mobile application to monitor plant performance online anywhere in world



Plant piping before modification



Automatic liquid level control, temperature control and hot gas defrosting system

- The overall above system improvement is anticipated to provide a Low Life Cycle Analysis (LLCA) and low carbon emissions where the refrigerating system gets greener and the energy savings add to the bottom line footprints.

The retrofit was performed successfully within 10 working days. This was done together with the valuable assistance of plant operators and one certified welder, without any downtime or disturbing status quo of plant operations. Once the required changes were in place and analysis performed against baseline and prevailing industry standards, the positive results achieved on the same was evaluated as follows:

- The compressor discharge pressure reduced significantly to 160 PSI from 220 PSI.
- The automatic operation of compressor units removed operator interference and resulted in smooth loading or unloading of each compressor. Additionally, overall energy requirement for compressor was reduced significantly.
- The safety valves and release system ensured increased safety at plant and no discharge of ammonia in plant in case safety valve pops up.
- The automatic ammonia leak detection and alarm system increased plant safety meeting OSHA's PSM requirements extending operator flexibility in working around the plant.
- The automatic hot gas defrost system replaced manual defrost operation.
- The defrost time was reduced to 15 minutes instead of 45 minutes.
- The increase in cold room or freezer room temperature during defrost reduced to 2°C from 10°C.
- The cold room or freezer room design temperature of -25°C was successfully achieved.
- The time required for freezer operation reduced 25 per cent.
- The number of compressors required reduced. The standby compressor remain as standby, was never required to operate.
- Reducing compressor running hours by 25 per cent.
- The automatic level control system made sure that ACU or freezer coils are flooded thus, preventing liquid slopover to the

compressor.

- The automatic level control system avoided operator's interference by throttling valves on receiver supply line.
- Oil accumulation in ACU and freezer units was eliminated.
- Frosting on ACU and freezer units eliminated.
- The online data logging and remote monitoring system installation helped customer to monitor the plant on mobile phone while travelling abroad.
- The temperature control system made sure that required temperatures are maintained continuously. No under shooting or overshooting observed. All temperature was maintained within ( $\pm$ ) 2°C.
- The weld in lines valves eliminated the leakages through flange joints of the valves.
- The back-seating facility in the valve assured operators that now they don't have to pursue in tightening valve glands.

### Looking Ahead

Thus, overall plant performance is improved by:

1. Reducing the plant operation time.
2. Improving plant temperature.
3. Operating at optimum suction and discharge pressure.
4. The ammonia odour from plant room vanished.
5. Increased plant safety and performance.
6. The automation of compressor, defrost system, liquid level control and plant monitoring allowed operators address other maintenance issues.

After observing a trouble-free plant operation for a period of one year, an estimated 30 per cent energy saving was derived with an overall payback recovered within four months. Additionally, it also improved product (ice cream) quality and production capacity as compared to (prior to above improvement) previous year. ■

Anand Joshi  
Partner  
Manik Engineers



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## Can heat pumps account for more business in commercial & industrial applications?

The bulk of India's power needs are for its industry. There will be a huge potential need for industrial heat pumps in many different industrial segments, with required temperatures expected to reach 100 C

Heat pumps have become established in recent years as the standard solution for heating residential buildings, detached and semi-detached houses in particular. The focus is now extending more to applications in commercial and industrial environments. Are heat pumps market-ready for these applications? Is there enough market potential for them? The following information will be of particular interest to planners, plant manufacturers, businesses in the field, operators, and employees of heat pump manufacturers.

About 78,000 heat pumps were sold in Germany for heating purposes in 2017 – the first time the sales volume has ever reached that level. Growth was strongest in the area of air-based heat pumps, with sales of 55,000 units, a rise of 20 per cent. There was also an increase in sales of heat pumps for domestic hot water heating, which were up 8 per cent compared to 2016, to 13,500 units. A total of 91,500 heat pumps were therefore put into service in Germany last year. This helped to set a further record, since it took the total number of installed heat pumps to more than one million, according to the latest information from German Heating Industry Association BDH, based on surveys by the chimney sweeping trade. Around 43 per cent of the residential buildings approved in 2017 were fitted with heat pumps, making these the most popular heating system for the first time, overtaking gas as the leading energy source.

### Interesting development in commercial and industrial settings

Virtually no statistics have been gathered regarding the use of heat pumps in commercial and industrial settings. This does not mean, however, that there are no developments of interest to report here, or that they are not being put to successful use. The European Heat Pump Summit in 2017 provided an opportunity for professionals to learn about the many successful applications in many different industries worldwide.

### India has huge potential for industrial heat pumps

For example, the presentation "Unlocking the Potential" by

Madhavan Nampoothiri highlighted the importance of industrial heat pumps in India for the summit participants. "By 2025, India will be the world's third-largest economic region, ahead of Germany. The bulk of India's power needs are for its industry. There will be a huge potential need for industrial heat pumps in many different industrial segments, with required temperatures expected to reach 100 C," Nampoothiri observes.

### Japan – a trailblazer in industrial heat pump use

Japan illustrated an application for the metal-working industry in an automotive supplier plant in which the heat pump can heat and cool simultaneously, and where the various operating settings were adjusted to suit requirements. This solution has already been put into practice in 110 heat pumps used for this application in Japan and other countries.

### Energy transformation is a huge driver – in Europe, too

Industrial heat pumps are also experiencing very satisfactory progress in Austria: 62 examples from more than 160 existing plants have already been documented. The presentation on high-temperature heat pumps includes an overview of the manufacturers and their programmes. The data that has been gathered on the temperatures needed in the various applications is also of interest.

### What is the situation in Germany?

"In Germany, in particular, the low price for gas and the high electricity price are tending to slow the rate of growth in the commercial and industrial use of heat pumps," observes Dr Rainer Jakobs, Operating Agent of IEA-HPT Annex 48, Industrial heat pumps. "Industrial heat pumps are much more important in other parts of the world than in Germany. But commercial and industrial users and policy-makers in Germany are steadily growing more aware of the benefits to be had from saving energy and costs, and the significant reduction in greenhouse gas emissions." ■

Source: Chillventa 2018

# IoT makes comfort systems smarter

Internet of Things, or commonly known as IoT, is a system of smart devices that communicate with each other on real time basis, usually takes the form of smart thermostats and sensors continuously monitoring environmental changes as well as equipment, part functioning and communicating back and forth, there are several technologies available, simple data collection, communication through Mobile App, Augmented Reality, Artificial Intelligence etc.

IoT based technology are also making cooling systems smarter. This is true not only for large HVAC equipment like chillers, but also for AC units used at residences, small office set-ups, etc.

Sensors are embedded in these products, which enables remote control by the users. Thus, a user can switch ON or OFF his IoT-enabled AC unit with the help of a mobile phone, through

GSM network, even when he is far away from the machine, physically.

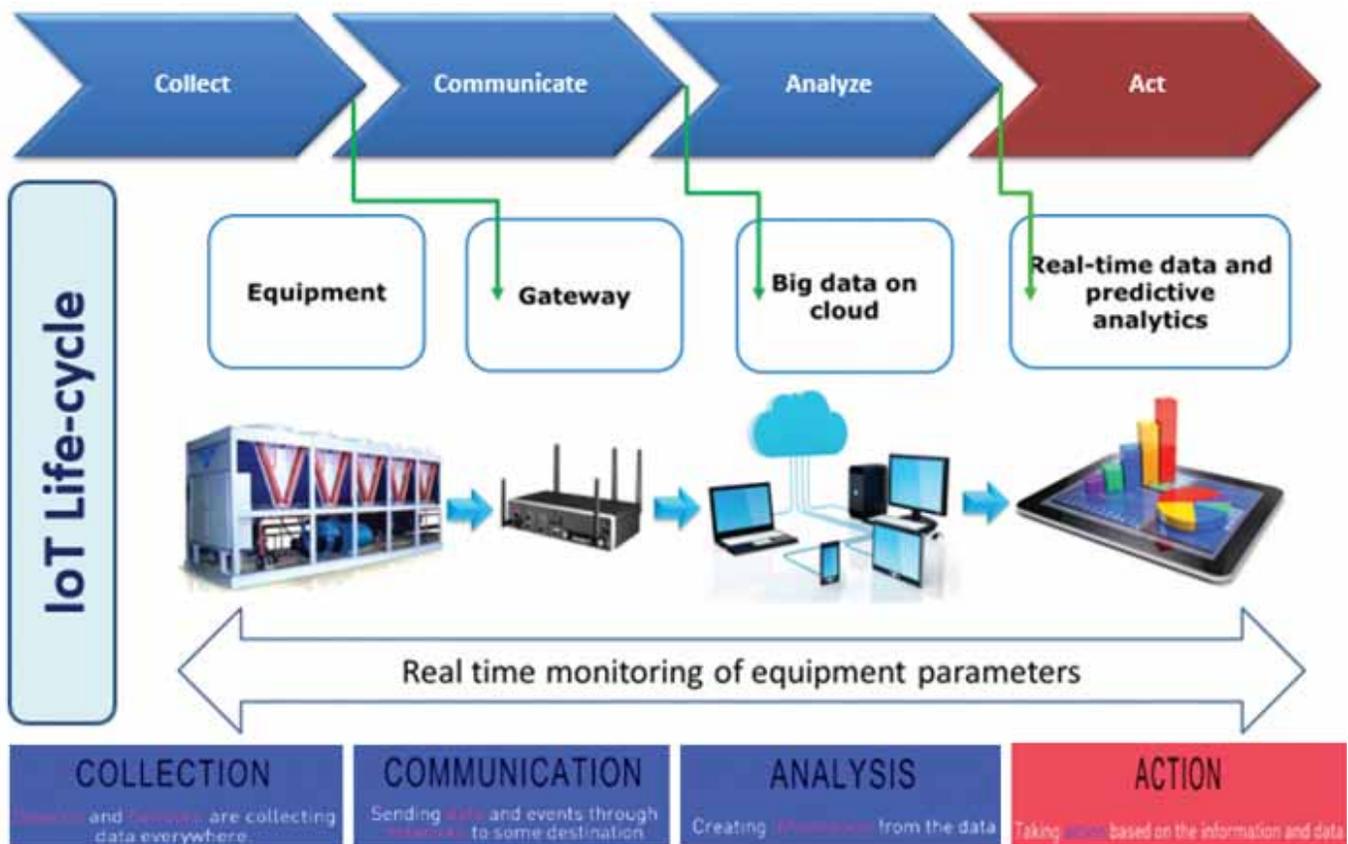
This feature can thus provide:

- Pre-cooling, even before the user has actually occupied his air-conditioned space, and
- Save precious electrical energy, in case the user has forgotten to switch-off his AC unit before leaving his air-conditioned space.

## Advantages of IoT-enabled HVAC systems over traditional ones

IoT-enabled HVAC systems, comprise of equipment which are provided with special sensors or connected to gateways for obtaining desired data from these machines.

All these data, when collected from the connected equipment,



can provide insights into equipment reliability, operating parameters and conditions during operations. This information, when analysed, can be valuable for:

- Manufacturing and quality control teams for products improvement.
- After-sales service team for improving their service deliverables, including faster response to customers, prevention and prediction of equipment failures.



**IoT based technology are also making cooling systems smarter. This is true not only for large HVAC equipment like chillers, but also for AC units used at residences, small office set-ups, etc.**

Accurate data and related analytics being generated from an IoT-enabled system, has the potential to alter the way an organisation delivers service:

Whether it is in resolving service complaints remotely

Or

By proactively deploying field personnel to take corrective actions and arrest a failure

Or

By providing detailed diagnosis and past usage records, while

troubleshooting a technical problem

Or

By replacing manual and routine activities such as logging of inside conditions of air-conditioned spaces, at regular intervals, in geographically-spread large or sensitive sites.

There are several benefits such as real time monitoring, reduction in equipment failures, optimisation in energy consumption of the operating equipment and related associated system, predictive maintenance, total controllability, improved adherence to service level agreements by reducing outages/downtimes, continuous comfort and increased efficiency

As a result of all the above points, providing IoT-enabled HVAC system becomes a key differentiator vis-à-vis other players offering traditional equipment and thereby upholds the brand image of the service provider.

This in turn, helps grow the service business revenue, with more and more customers entrusting maintenance contracts to the smart service provider. ■

**M Gopi Krishna**  
Executive Vice President & COO,  
Domestic Projects Group,  
Voltas Limited



## USGBC Announces New Initiatives & Updates to LEED

The Greenbuild International Conference and Expo by the US Green Building Council (USGBC) concluded recently in Chicago, where thousands of members of the global green building community gathered.

The theme for this year's Greenbuild was Human X Nature, representing how the green building movement embraces all of humanity by making sustainable buildings and environments accessible to everyone. USGBC's President and CEO Mahesh Ramanujam also gave powerful remarks highlighting plans for the future and USGBC's role in creating a new living standard for all people. "In the past, we have delivered on our promises of certifications, signifying high quality spaces in which we can live and work," said Ramanujam. "Now, by harnessing the power of our partnerships with companies and organisations the world over, we will explore creating a new campaign – a living standard that indicates that an environment is healthy and safe for all who inhabit it – from buildings, to communities, to cities, to entire nations. Because a higher living standard is what every person on the planet deserves."

Several programmatic updates to the LEED green building rating system were announced throughout the week including:

**LEED Transit Rating System:** USGBC released LEED green building certification standards for new transit stations, which were also announced during Greenbuild India. LEED Transit was developed with valuable input from the Delhi Metro Rail Corporation in India (DMRC), Shanghai Shentong Metro Group for China (Shentong), and Shanghai Green City Architectural Technology. With LEED Transit, transit owners can reduce their environmental footprint, while also engaging riders on the importance of sustainability and the opportunity the public transportation sector has in minimising greenhouse gas emissions.

**LEED Zero Certification:** USGBC officially introduced a new LEED Zero certification offering. The new program recognises buildings or spaces operating with net zero carbon emissions from energy consumption and occupant transportation to carbon emissions avoided or offset over a period of 12 months. LEED projects can achieve LEED Zero certification when they

demonstrate any or one of the net zero carbon emissions, net zero energy use, net zero water use or net zero waste.

**Integration of STAR and LEED for Cities and LEED for Communities:** It was announced that the STAR Community Rating System, which offers certification for sustainable communities, has been fully integrated into USGBC's LEED for Cities and LEED for Communities programs to help advance sustainable cities and communities worldwide. There are currently 75 cities and communities that have achieved STAR certification and 20 additional cities and communities that are seeking STAR certification.

**LEED Recertification:** USGBC announced that it will begin offering LEED recertification. All LEED projects – past, present and future – are now eligible for recertification by providing 12 months of data, powered by Arc that shows consistent or improved performance, using the most recent version of the LEED rating system. This recertification will be valid for three years and is an important step in ensuring that a green building is operating the way it was intended. ■



## FLIR thermal imaging cameras help home inspectors catch & prevent problems

Texas home inspector Craig Lemmon uses FLIR T-Series infrared camera. It ensures that his inspections are thorough, and he catches problems that inspectors without an infrared camera.

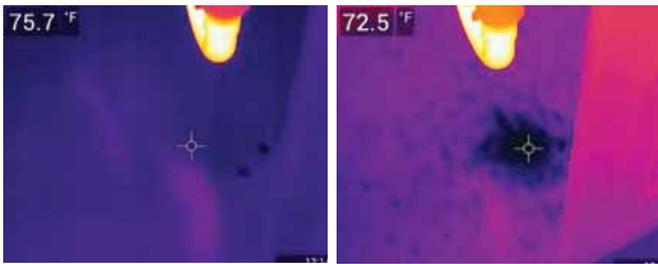


FLIR T500-Series Professional Thermal Imaging Cameras

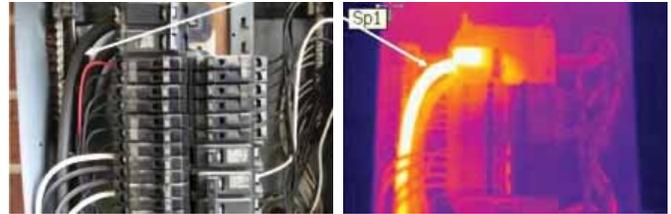
Home buyers rely on inspectors to catch problems before they seal the deal on their future home. If anything is missed, it could cost the buyer thousands of dollars in repairs and the inspector his credibility. That's why Texas home inspector Craig Lemmon refuses to do the job without his FLIR T-Series infrared camera. It ensures that his inspections are

thorough, and he catches problems that inspectors without an infrared camera would miss.

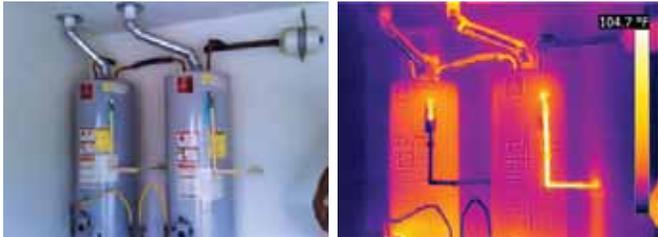
Craig Lemmon has owned real estate inspections of Texas for the past 17 years. In his earliest days, his essential inspection tools were his eyes, a mini temperature gun, and a flashlight. When he discovered thermal imaging cameras in 2004, he realised they could help him find problems that a flashlight alone couldn't. He bought one and never looked back. "I will not perform an inspection without my FLIR—it's my most-used inspection tool," says Lemmon. He finds and prevents problems every single day using a thermal camera. Lemmon owns several kinds of thermal cameras, but his favorite is a FLIR T-Series with high resolution and sensitivity to see fine details. He estimates that only 25 to 35 per cent of home inspectors use thermal imaging, and most who do will purchase an introductory unit that barely meets RESNET (Residential Energy Standards Network) standards. In Lemmon's experience, a high-resolution thermal camera that can measure higher temperatures is ideal for finding faults. It has helped him detect Freon leaks from HVAC systems, hot electrical wires, hot breakers in panels, insulation voids in walls, and many other problems that he never would have caught without a thermal imager. In one home inspection, Lemmon noticed two small drops of water under the bathroom sink using



Two drops of water from a leaky sink      Same leak 26 minutes later



Thermal imaging reveals overheating wire in electrical panel



Issue with a hot water heater



Moisture found in master bedroom wall

a FLIR T-Series thermal camera. He found that the seal on the stopper had not been installed properly and could have ruined the cabinets as well as the hardwood floors and walls in the surrounding area. Since the issue was caught during inspection, it could be repaired before there were any damages. If he had used a lower-resolution thermal camera, he likely would have missed the leak.

In another case, Lemmon found a small temperature difference on a 30-foot-high ceiling. It turned out that a fault in the roofing installation allowed moisture to leak in and could have caused a major problem if left undetected. He also discovered a cracked heat exchanger in a HVAC furnace. The home buyer negotiated a repair and saved USD 4,000. Lemmon says having a professional-level thermal imager gives him such an advantage over the competition that he can raise his rates, billing up to USD 35,000 more per year for his business. "Times have changed for inspectors. From laptops to digital cameras, wet wall detectors, and drones – this is one of those things that can put you head and shoulders above the others," he says. Thermal imaging has served as an invaluable tool when reporting problems to customers. By showing them thermal images of issues discovered during inspection, Lemmon can provide a more accurate and detailed analysis. His camera's Delta T feature makes it easy to

show the severity of an issue.

From water temperature in a faucet to the temperature of an AC vent, Lemmon documents everything. "I feel that documentation is key, and FLIR makes this simple," he says. "I do it for three people: the home buyer, myself, and the judge – in case anything ever goes wrong in the future." He loves that his T-Series camera makes reporting simple. "There's no need to process my photos in a special program," Lemmon says. "I can simply drop the photo into my Microsoft Word document and if needed, I can analyse it in the same program. Some inspectors will create reports at the end of the day, but I can do the report on-site and am basically done before I leave the house I am inspecting." Lemmon believes the top problem for a home inspector is having enough time to do it all. "Finding a way to make your inspection as efficient as possible while ensuring you do the best job is challenging," he says. "My FLIR camera makes it easy to do the best inspection while making the most of my time. Whether it is the file format, features like the 1-touch level or span, or even just the speedy way it helps you build reports, the time saved is amazing. This time savings allows me to perform another inspection in my work day, or more importantly, get home to see my grandkids." ■

For further information, log on to [www.flir.com](http://www.flir.com)

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## Chillventa impresses with new records and an upbeat mood!

“With the significant increase in exhibitor and visitor numbers from Germany and around the world, Chillventa is reinforcing its position as the world’s leading trade fair for refrigeration technology”

Chillventa 2018 was a resounding success. Once again, it saw significant increases in all trade fair KPIs. An increase of over 10 per cent to 35,490 trade visitors, around 4 per cent growth to 1,019 exhibitors and last but not least, a 2 per cent rise in display area make it the biggest Chillventa ever. From 16 to 18 October, it transformed the Nuremberg exhibition venue into the No. 1 gathering place for the international refrigeration, AC, ventilation and heat pump community. On 15 October, the day before the fair, the Chillventa CONGRESS was a big hit with its audience of industry professionals. The high-calibre conference also broke a new record with 302 delegates in attendance (over 20 per cent).

“We are delighted about the excellent result of Chillventa 2018. After ten years, Chillventa 2018 reached a genuine milestone once again by welcoming 1,019 exhibitors from all over the world. And the icing on the cake was the record number of trade visitors, with 35,490 people attending Chillventa. However, it wasn’t just the numbers that impressed industry professionals but above all the fantastic atmosphere in the halls where experts came together with other experts. Chillventa is therefore once

again impressively underscoring its role as the most important gathering for the international refrigeration community including the segments AC, ventilation and heat pumps,” says Daniela Heinkel, Exhibition Director Chillventa at NürnbergMesse.

### Chillventa – leading international trade fair

There has always been a strong international contingent of exhibitors and visitors at Chillventa. This is also clear evidence of the global focus of the sector. Two-thirds of exhibitors come from outside Germany. The top five international participants are Italy, China, Turkey, Spain and France, while the UK, the USA, Belgium, the Czech Republic and the Netherlands are also in the top 10. There’s a similar pattern in respect of trade visitors, with more than half of Chillventa’s 35,490 visitors travelling from all around the world to the Nuremberg exhibition venue.

“With the significant increase in exhibitor and visitor numbers from Germany and around the world, Chillventa is reinforcing its position as the world’s leading trade fair for refrigeration technology,” says Richard Krowoza, member of the Management Board, NürnbergMesse.



Chillventa AWARD



Chillventa CONGRESS



### Trade visitors are very satisfied with Chillventa

The importance of Chillventa is also reflected in the high percentage of decision-makers in attendance. Eight out of ten trade visitors stated that they were involved in purchasing or procurement processes, while 98 per cent of visitors were satisfied with the range of products and solutions at Chillventa. The fact that nine out of ten visitors stated that they intended to attend the next Chillventa in 2020 shows how committed the industry is to this event.

### Exhibitors praise Chillventa 2018

This year too, there was a great atmosphere in the packed exhibition halls at Chillventa, where experts met and talked with other experts. This positive image was also confirmed by the independent exhibitor poll, in which 94 per cent of exhibiting companies stated that the event had been a success for them. Around 95 per cent were able to forge new business contacts and nine out of ten companies expected follow-on business from the event. Even before the fair was over, nine out of ten exhibitors said that they would be back in 2020.

### Chillventa CONGRESS

The Chillventa CONGRESS, along with the Exhibitor Forums in the halls, offered sound professional insights into the latest hot topics in the industry. "In more than 200 presentations over four

days and at seven different locations, conference participants and forum visitors were able to get comprehensive information about the industry including components, systems and applications for the segments refrigeration, AC, ventilation and heat pumps," explained Dr Rainer Jakobs, technical consultant and coordinator of the supporting programme at Chillventa. In 2018, the trade fair, exhibitor forums and CONGRESS also focused on the Internet of Things (IoT), the IT security of refrigeration systems, implementation of the 42nd regulation on evaporative cooling (BlmSchV), current climate targets, eco-design, reclamation and treatment of refrigerants, F-gas regulations, efficiency through controls, innovation in heat transfer, air conditioning of data centres, heat recovery and system solutions for cold water.

### Special presentations offered practical expertise

The industry professionals at Chillventa were also impressed by two special presentations. There was plenty of expert knowledge to be had from the special display areas "Hygiene in air-charged heat exchangers" and "The heat pump: key technology for the successful energy transition".

### Chillventa AWARD presented

The Chillventa AWARD was presented for the second time in 2018. The awards were handed over to the winners at an official ceremony on the first day of the fair. ■

All photo credit: NürnbergMesse

*The next Chillventa will take place from 13 to 15 October 2020 at Exhibition Centre Nuremberg.*

### 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 & 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 is built to last and 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 & beverage, tyre, rubber to refinery. ■

Website: [www.thermaxglobal.com/process-cooling](http://www.thermaxglobal.com/process-cooling)

### Embraco's FMX Model

**T**he FMX is the latest generation of household solutions with Embraco Fullmotion Inverter technology. It is a compact product that brings advantages for applications with limited internal space and is designed to natural refrigerant R600a (isobutane) usage.

Through variable speed, the product features a wide voltage range, reduced



energy consumption as well as lower noise and vibration levels when compared to other solutions. Another advantage attributed to refrigerators equipped with FMX is better food preservation since the compressor maintains a stable temperature providing fresher and healthier food. ■

Website: [www.embraco.com](http://www.embraco.com)

### Danfoss' Reciprocating Compressors

**T**here is always a Danfoss Maneurop MT, MTZ, NTZ reciprocating compressor to fit various applications such as cold rooms, milk tanks, air dryers running in a wide range of operating conditions in medium and low temperature applications. The compressors are qualified for a number of refrigerants such as R404A, R134a, R407C or R407A or R407F but also for new lower GWP refrigerants such as R452A, R448A and R449A.

With Danfoss light compressors for commercial refrigeration BD, PL, TL, DL, NL, FR, SC, GS, D, U, L, P, X, S, Danfoss provides compressors tailored for applications in hotels, restaurants, catering, food and beverage, medical and lab equipment as well as mobile and telecom cooling. They operate with several refrigerants including Hydrocarbons offering an environmentally friendly solution.

With VTZxx, SLVxx, xxFSC and xxFSN inverter packages, Danfoss provides solutions for variable-speed operations

which offer excellence in:

- Capacity modulation and precision cooling - with stepless capacity control
- Energy savings - with high efficiency at part-load and improved SEER.

#### Features

- Integral compressors available in a large variety of single or tandem models
- 500-plus models of Light Commercial Compressors from 40W to 4750W, 1500+ options
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- Go green with R290 and R600a refrigerants on light commercial compressors. ■

Website: [www.danfoss.com](http://www.danfoss.com)

# Forthcoming Events At A Glance

## Food Show India

**Venue:** Mihan Industrial Area Nagpur, Maharashtra

**Date:** 16<sup>th</sup> to 18<sup>th</sup> January 2019

**Website:** [www.food-show.com](http://www.food-show.com)

## Global Logistic Show (GLS)

**Venue:** Hitex Exhibition Centre, Hyderabad

**Date:** 17<sup>th</sup> to 19<sup>th</sup> January 2019

**Website:** [www.globallogisticsshow.com](http://www.globallogisticsshow.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.dairytechpune.com](http://www.dairytechpune.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)

Company Name	Page No.
ACREX 2019	17
Allround (India) Vegetable Processing Machines Pvt. Ltd.	IBC
ebm-papst India Pvt. Ltd.	13
Eicher Trucks and Buses	FC
Embraco	29
Ensavior Technologies Pvt. Ltd.	BC
FLIR Systems India Pvt. Ltd.	15
Gandhi Automations Pvt. Ltd.	9
Johnson Controls - Hitachi Air Conditioning India Ltd.	5
Ice Make Refrigeration Limited	25
Samsung India Electronics Pvt. Ltd.	11
Thermax Ltd.	7
Werner Finley Pvt. Ltd.	3

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## Convention Center Achieves Sustainability

The Convention Center is one of the most important works done in the last years in Buenos Aires. It has a total capacity of approximately 5,000 people, with a plenary room and an auxiliary room, offices, meeting rooms and a 1,600 m<sup>2</sup> lobby. It consists of three underground levels to extend the landscape of the property between the University, Faculty of Law, and Thays Park. In total, it has an outdoor park of 18 thousand square meters.

In addition to preserving green space and old trees, the Center has a strong focus on sustainability, thanks to big windows and LED lighting to save energy, rainwater collection and solar panels.



Even the HVAC system has been designed in a highly sustainable way.

As the building is fully underground, it is not affected by external thermal loads during the day. Furthermore, the green covering provides insulation on the roof from solar radiation, keeping internal temperature stable all year round. To guarantee the best internal comfort

even during the most crowded events, the HVAC plant designer has conceived an air conditioning system based on Climaveneta branded units: 1 ERACS2-Q/CA 2222 multi-purpose heat pump and 1 FOCS2/K 6903 chiller, to produce hot and cold water for the 11 Wizard Air Handling Units. ■

## Paramount's Entire San Francisco Portfolio Achieves LEED Platinum Status

Paramount Group announced that One Front Street and 50 Beale Street have just received the coveted LEED Platinum certification, the highest rating awarded by the US Green Building Council. With this achievement, Paramount's entire San Francisco portfolio aggregating 2.9 million square feet is now LEED Platinum certified, reflecting Paramount's commitment.

"Having all three of our San Francisco properties receive the prestigious LEED Platinum certification is a significant achievement that demonstrates our commitment to sustainability and operational excellence," said Albert Behler, Chairman, Chief Executive Officer and President of Paramount.



"The steps we have taken to upgrade the quality of our portfolio have resulted in all of our properties being either LEED Platinum or Gold certified, helping to improve our environmental and financial results." The criteria for achieving LEED Platinum certification is both intensive and comprehensive.

Properties pursuing LEED Platinum qualification must earn 80+ cumulative points across nine categories: Location & Transportation, Sustainable Sites, Water Efficiency, Energy & Atmosphere, Material & Resources, Indoor Environmental Quality, Innovation, Regional Priority and Integrative Process. ■

## Sustainability Award for UCLA

UCLA earned an award for the sustainable design of its athletics facilities from the Los Angeles chapter of the US Green Building Council. USGBC LA gave UCLA the award because both the Wasserman Football Center and Mo Ostin Basketball Center had obtained Leadership in Energy and Environmental Design Platinum certification, the highest rating awarded to green buildings. UCLA policy has required all new constructed buildings on campus to obtain LEED certification since 2006. The sustainable designs of the two training centers were part of University of California President Janet Napolitano's initiative to establish the UC as the first research university to achieve carbon neutrality. The facilities are also part of the Sustainable LA Grand Challenge, a university wide initiative aimed at helping LA achieve 100 per cent sustainability in energy, water and biodiversity by 2050.



The UCLA Wasserman Football Center employs water-saving strategies, including efficient plumbing solutions and grey water management programs. This strategic planning achieved a 72 per cent reduction in the facility's water use, saving the training center approximately 197,000 gallons in total, according to USGBC LA. ■

**Sorting, Grading, Packaging Line, Bulk & Box Storage For Onion, Potato, Garlic, Other Vegetables & Fruits**

**Shake Grading Line SG80 Series**



Capacity : 10 to 30 tons/hour  
 Grading Size : 3 to 6 grades  
 Optional : Fully & semi automatic with retail packings

**Weigher & Bagging AWBS25**



Capacity : 1 to 7.5 tons depends on bag weight.  
 Weight range : 5 to 50 kg.  
 Bagger type : Raschel

**Turn key Chiller (TKC)**



- Plug & play cooling machine
- Quick & easy installation.
- Eco-friendly refrigerants.

**Heat Exchanger**



- Controls the CO<sub>2</sub> under all conditions
- Energy savings 90%
- Standard unit for up to 1000 ton potatoes, carrots.

**Bulk Storage**



The most effective & economical way of storage.  
 Products to be stored : Industrial potatoes, Onions, Table potatoes etc.

**Box Storage**



The most flexible way of storage.  
 Products to be stored : Potatos, Onions, Cabbage, Red beet, Fruits etc.



**FlowCon**  
international



**ENERGY  
FIT  
SYSTEM**



## The FlowCon Energy FIT System is typically installed on AHUs or in the Plantroom and includes:



### Intelligent Interface

Connects all FIT components and BMS.



### PICV with Electrical Display Actuator

Maintains correct flow despite pressure changes.



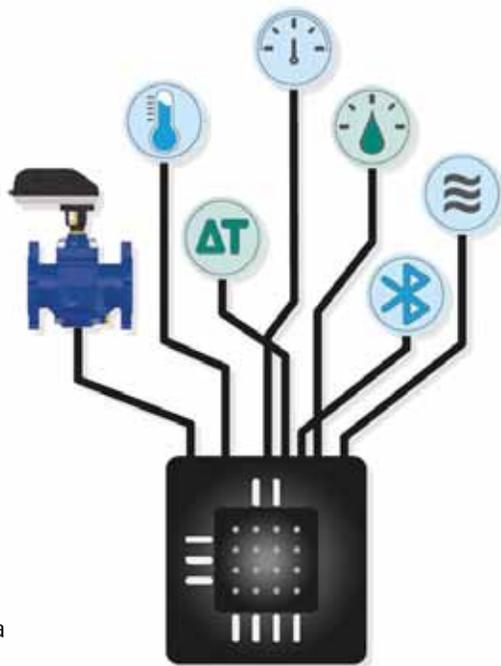
### Pressure Sensors

Measure up/downstream pressure allowing the BMS to lower system pressure to PICV's requirements.



### Integrated BTU meter

Calculates the BTU and displays data via Bluetooth® on cell phone or in BMS.



### Temperature Sensors

Measure the  $\Delta T$  across the coil.

### Integrated Flow meter

Calculates the flow and displays data via Bluetooth® on cell phone or in BMS.

### Bluetooth®

With FlowCon App, the Intelligent Interface can provide readings from the FIT System directly via Bluetooth®. Data includes T1, T2,  $\Delta T$ , P1, P2,  $\Delta P$ , Flow, BTU and  $\Delta T$  Target.

### $\Delta T$ control

Flow only changes when demand requirements change or  $\Delta T$  is outside of specification - The FIT System provides full  $\Delta T$  control.



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