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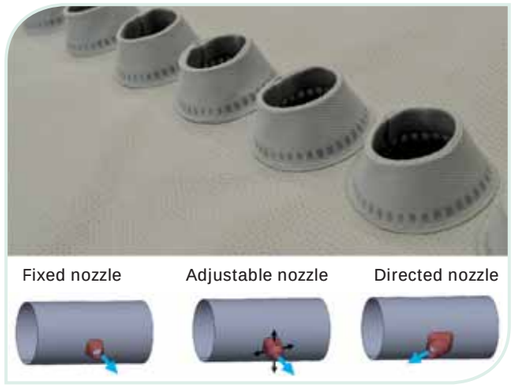
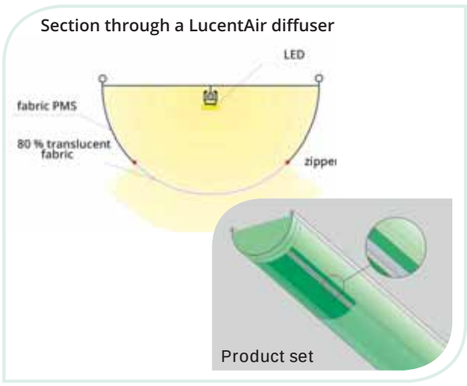
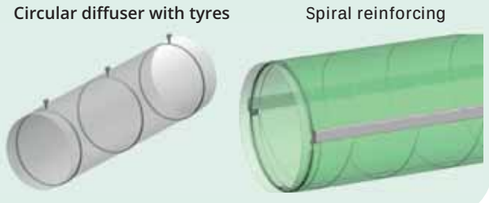


LUCENT AIR COMBINATION OF AIR DISTRIBUTION WITH LIGHTING



INTERNAL TENSIONING SYSTEM TO MAINTAIN SHAPE EVEN THERE IS NO AIR



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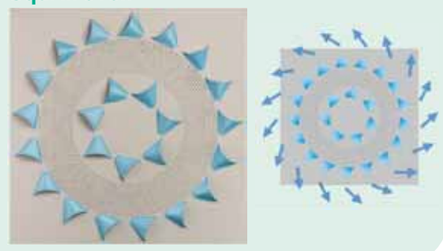
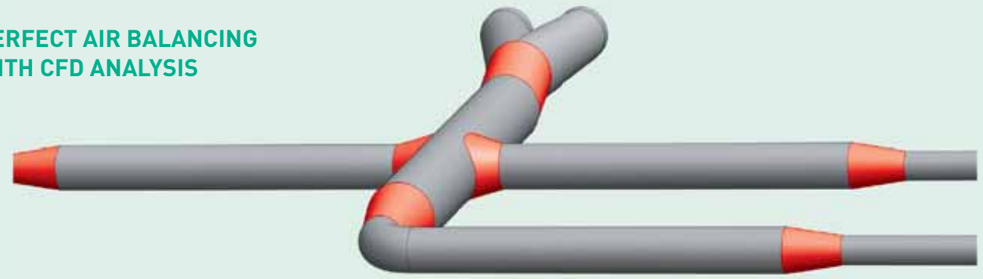
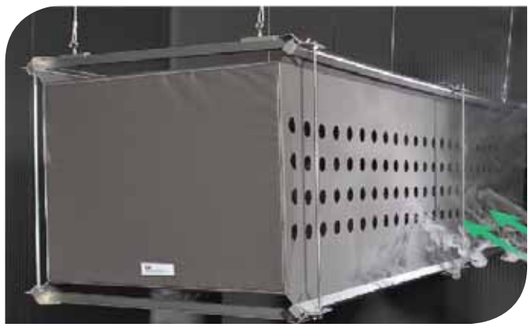


PERFECT AIR BALANCING WITH CFD ANALYSIS



NEGATIVE PRESSURE (EXHAUST) DUCTING



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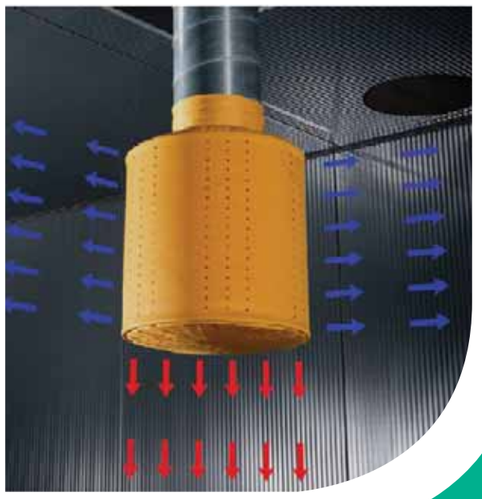

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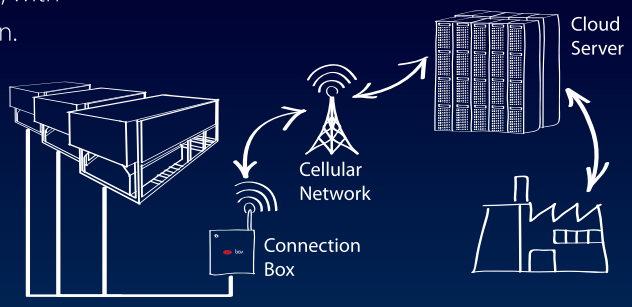

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Publisher's Letter

Hello and welcome once again to *Cooling India*.

It's no secret the world has been changing before our eyes. Likewise, HVACR industry is witnessing technological transformation like never before. Growing infrastructure-based developments, rising disposable income and increasing awareness about climate change are driving the growth for HVACR industry in India. According to industry estimate, Indian HVAC market is expected to cross $7 billion by 2022. Further, with a shift towards smarter ecosystem, including smart homes and smart factories, the demand for intelligent HVACR equipment is on a higher growth trajectory.

On this note, this time, we bring you this exclusive issue on 'Top HVACR Products' wherein we feature some of the advanced solutions that will push HVACR industry growth. We hope you'll enjoy reading this issue as always!

Globally, food processing has become an integral part of the food supply chain and India has also seen remarkable growth in this sector in the last few years. However, gaps in the supply chain remains the biggest challenge faced by Indian food processing industry.

An efficient cold chain offers great potential to drive and benefit agricultural, horticultural and dairy production. Of late, the NDA government at the centre has expressed its commitment to develop the cold chain industry and increase warehousing capacity and supports private participation through various subsidy schemes and grants. In this direction, an Agri-Market Infrastructure Fund with a corpus of Rs. 2,000 crore was announced in the 2018-19 Budget for upgrading of 22,000 rural haats into Gramin Agriculture Markets (GrAMS). Coming July, Cooling India will come with a special issue on agriculture and horticulture HVACR wherein we'll discuss on how advanced technologies can help food processing industry to move forward while creating new value for businesses. We invite you to be a part of this upcoming issue.

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USGBC Gets $500,000 grant from Bank of America for LEED

The US Green Building Council (USGBC), creators of the Leadership in Energy & Environmental Design (LEED) green building program, announced a new USD 500,000 grant from Bank of America. The funding supports the LEED certification of 15 US cities and communities. The grant provides financial assistance, educational resources and technical support throughout the certification process. USGBC and Bank of America launched the LEED for Cities and Communities grant program with six US cities in 2018.

"To realise a sustainable future for all, today's cities and communities must strive to be green, resilient, inclusive and smart," said Mahesh Ramanujam, President and CEO, USGBC. "The LEED for Cities and Communities certification programs give leaders a framework for planning, designing, measuring and managing the social, economic and environmental performance of the places where they live, work, learn and play. With support from Bank of America, we will empower these grant recipients to deliver a higher living standard for their residents." LEED is the world's most widely used green building rating system, and earlier this year, USGBC released the newest version of the program, LEED v4.1. LEED helps local governments develop and track plans for a wide variety of factors, including green infrastructure, public health, energy, social equity, transportation and more. Bank of America is a longtime member of USGBC and has pursued LEED certification for its own operations. Presently, the company has 19 million square feet of LEED-certified workspace, including more than 200 LEED-certified financial centers.

"USGBC is a leader in creating more environmentally sustainable buildings, cities and communities," said Alex Liftman, Global Environmental executive at Bank of America. " ■

ASHRAE Signs MoU Agreement with New Buildings Institute

ASHRAE and New Buildings Institute (NBI) have signed a new Memorandum of Understanding (MoU) formalising the organisations' relationship.

The MoU was signed by 2018-2019 ASHRAE President Sheila J Hayter, P E and NBI CEO Ralph DiNola, on May 14 in Seattle. The agreement defines parameters on how the two organisations will collaborate more closely to continue to advance and promote the mutual interests of their respective members and stakeholders.

This agreement compliments Hayter's theme for the Society year 'Building Our New Energy Future,' and is focused on three main areas of collaboration that will be further detailed in a future partnership agreement on zero energy or emissions building leadership and market development, education and design guidance and advancing codes and policies.

"ASHRAE believes in the impact of our collaborative efforts in accelerating meaningful progress toward optimising the design and performance of buildings," said 2018-2019 ASHRAE President Sheila J Hayter, PE. "NBI's commitment to better energy performance and emission reductions in buildings aligns well with ASHRAE's industry longstanding leadership in advancing the growth and innovation of the built environment. We are pleased to sign this MoU and look forward to working with NBI."

Parameters of the agreement include but are not limited to general advocacy; joint conferences and meetings; chapter collaboration; publication development and distribution; education and training programs; technical activities coordination and research.

"We value this partnership with ASHRAE and are excited to leverage this collaboration to better support ASHRAE's members with tools, resources, training and education to rapidly scale zero energy and zero emissions buildings," said NBI CEO Ralph DiNola. "This MoU will focus our efforts and help us to plan our successful collaboration into the future and significantly increase our impact." ■

Mitsubishi Electric Trane HVAC becomes operational

Ingersoll-Rand, a manufacturer in creating comfortable, sustainable and efficient environments, and Mitsubishi Electric Corporation, a manufacturer of technologically advanced ductless and Variable Refrigerant Flow (VRF) cooling and heating systems, announced that its joint venture is now operating and serving customers.

The joint venture establishes Mitsubishi Electric Trane HVAC US as a provider of ductless and VRF systems in the United States and selected countries in Latin America. The systems sold by the joint venture are highly efficient, variable-speed mini-split, multi-split, and VRF air conditioners and heat pumps for homes, light commercial and commercial applications. Keijiro Hora has been named Chief Executive Officer and D Andrew Kelso has been named Chief Financial Officer. Hora has been with Mitsubishi Electric since 1981, most recently as president and chief executive officer of Mitsubishi Electric US, Inc., a role that he will continue to hold. Kelso has been with Ingersoll Rand since 1995, most recently as the finance leader for the company's Industrial Products businesses.

Ingersoll Rand and Mitsubishi Electric Corporation each have equal ownership of Mitsubishi Electric Trane HVAC US. ■

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Blue Star in Forbes' Best under a Billion list

Blue Star, one of the leading central air conditioning and commercial refrigeration company, has been named in the latest '200 Best under a Billion' list for the Asia Pacific region by US magazine, Forbes.

The annual 'Best under a Billion' list picks the best 200 small and medium sized companies from 24,155 listed firms with sales of less than USD 1 billion in the Asia Pacific region. The companies are chosen based on their record of consistent growth and profitability.

The list appeared in the September 29 issue of Forbes Asia. Only 22 Indian companies found a place in the list of 200 and Blue Star is one of them. Blue Star has posted consistent growth in sales and profits over the last several years. For the year ended March 31, 2008, its total income increased by 41 per cent to Rs 2270 crore and profit after tax by 145 per cent to Rs174.09 crore.

Commenting on the achievement, B Thiagarajan, Executive Vice President, Blue Star said, "We are pleased about the fact that Forbes Asia has picked Blue Star as one of the 200 outstanding companies in the Asia Pacific region. The company's unwavering focus on profitable growth has clearly produced good results. This achievement is a result of sound strategy implemented with great commitment and competence by the entire Blue Star team."

Ashok M Advani, Chairman and Managing Director says, "2007-08 was, by far, the best year in Blue Star's 65-year old history. Record top-line growth, lower costs and tight operational control have led to this exceptional financial performance. We have achieved steadily improving results over a number of years in a competitive market and this gives me confidence that Blue Star will sustain its momentum of high growth and profitability in the current year." ■

UL & Eurovent Middle East to work for improved IAQ

Underwriter Laboratories (UL) and Eurovent Middle East have announced their cooperation in the region to work towards higher safety standards in relation to HVAC equipment and installations. Both organisations also will form a joint working group to develop initiatives for improved Indoor Air Quality (IAQ). To underline this cooperation, UL takes an associate membership with Eurovent Middle East. UL is recognised worldwide for its testing standards and programs. UL brings clarity and empowers trust to support the responsible development, production, marketing and purchase of goods, solutions and innovations of today and tomorrow. It enables safer, more secure, more sustainable products, services, experiences and environments – leading to smarter choices and better lives.

Nils Meinhardt, Global Business Development Manager HVAC, UL, stated, "UL and Eurovent Middle East have the same intentions and targets like improving standards and quality in the region and support the development of a sustainable environment for the countries and its people in the Middle East. Joining forces enables us to use synergies and double our efforts in raising awareness on issues like safety and IAQ."

Markus Lattner, Managing Director of Eurovent Middle East, added, "UL has a strong reputation in fire and electrical safety, but is active in many more areas as well. The cooperation of our organisations in areas like IAQ will give joint recommendations great credibility. It will help us to contribute to a better living environment in the Middle East."

Eurovent Middle East is the region's only industry association representing leading manufacturers of Indoor Climate (HVAC), Process Cooling, Food Cold Chain, Industrial Ventilation, and Building Automation Technologies, as well as sector associations and industry initiatives active in these fields. ■

ebm-papst strengthens US business with second location

ebm-papst is strengthening its business in North America with a second production site. In Johnson City, Tennessee, one of the market leaders for fans and motors will manufacture fans for refrigeration, air conditioning and ventilation applications. ebm-papst will move into an existing production building in Johnson City and start serial production in September 2019.

In an industrial park near Johnson City, Tennessee, ebm-papst has acquired 30 acres (12 hectares) of land and plans to invest USD 37 million for the expansion of a new plant. Over the next five years, ebm-papst will invest around USD 37 million in its expansion in Johnson City and plans to employ up to 200 people. Mark Shiring, President of ebm-papst US, "Johnson City offers us an excellent infrastructure and very good development opportunities. We are, therefore, very pleased to be able to start production at our second US site shortly. As an innovation leader, especially, for energy-efficient fan solutions, we see great potential for further growth in North America. For us, the new location is an excellent complement to our headquarters in Farmington."

Stefan Brandl, President and CEO of the ebm-papst Group, "With our additional location in Johnson City, we are increasing our activities on the US market in line with our internationalisation strategy "local for local". I am very optimistic that we will achieve our goals with our entire American team and that we will be able to further expand our market position". ■

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Schneider Electric ranked 11th in Gartner Supply Chain

Schneider Electric, one of the leaders in digital transformation of energy management and automation, announced it has been ranked 11th in The Gartner Supply Chain Top 25 for 2019.

The group also won the 2019 Industrial Manufacturing Supply Chainnovator Award in Gartner's 2019 Supply Chainnovator Awards which recognises unconventional, innovative and high-impact supply chain initiatives in the industrial manufacturing sector. Gartner announced these awards during its Gartner Supply Chain Executive Conference 2019 in Phoenix, Arizona in the United States. "We are really overjoyed that we have improved our position again this year on The Gartner Supply Chain Top 25 rankings. We believe our transformation efforts in the supply chain are progressing well and that this really gives our team the inspiration to push forward on our Tailored, Sustainable and Connected 4.0 Supply Chain program, together with our partners for our customers. We see the Industrial Manufacturing Supply Chainnovator award as a recognition for our people strategy supporting this digital transformation which spans our entire workforce. This is especially significant for us as our people are the cornerstone in our supply chain," said Mourad Tamoud, Executive Vice President, Schneider Electric Global Supply Chain.

As of 2018, Schneider's Global Supply Chain Operations comprising of 200 manufacturing plants in 46 countries and 98 distribution centres, saw its 86,000-strong workforce manage over 260,000 references and process over 150,000 order lines daily.

According to Gartner in its Supply Chain Top 25 announcement, "three key trends stand out this year for supply chain leaders that are accelerating their capabilities, separating them further from the rest of the pack: personalisation at scale, leveraging ecosystems & driving business-led digital strategies." ■

Naci Sahin elected as new President of Eurovent Association

During the Eurovent Annual Meeting in Oslo, members have confirmed Naci Sahin as their new President. The Managing Director of the Turkish company, FRITERM has been member of the Eurovent Board of Directors since 2011 and succeeds Alex Rasmussen. Sahin used to be President of Eurovent's Turkish member association ISKID from 2013 to 2014 and has been playing a leading role in shaping the internationalisation of the Turkish HVACR industry over the past decades.

With Naci Sahin, Eurovent welcomes its first-ever President from Turkey. The association is representing associations and manufacturers from all over Europe (not only EU Member States). Turkish manufacturers have been actively participating in Eurovent activities since the Turkish sector federation ISKID has joined Eurovent in 1997. The outgoing President Alex Rasmussen, who had been successfully leading the association for the past three years, is going to continue as first Vice-President and will remain responsible for the European Union policy matters.

Following his election, Naci Sahin stated, "The Eurovent Certification schemes have pushed the industry to set the bars higher. A particular focus will be put on further increasing European industry cooperation and unity." ■

Kissht to provide Blue Star's clients with 0% interest EMI scheme

India's one of the leading fintech consumer lending platform, Kissht, announced its strategic expansion plan to provide 0 per cent interest EMI scheme to new to credit (NTC) customers of one of India's air conditioning and commercial refrigeration major, Blue Star across Blue Star's line of products including air conditioners, air coolers, air purifiers, water purifiers, and specialty cooling products, amongst others. More than 5,000 outlets have activated this scheme across the country.

The buyer can choose from attractive EMI options according to their convenience on a loan amount that can be availed ranging from Rs 5000/- to Rs 1,50,000/-. This scheme is available across all the channel partners of Blue Star. Customers from both Tier 1 and Tier 2 cities in India can avail this offer of easy EMI with 0 per cent interest and Zero Processing Fee.

Speaking about this expansion plan of joining hands with Blue Star, Krishnan Vishwanathan, CEO and Founder, Kissht said, "We believe that our partnership with Blue Star will help make quality of living more accessible to the lower income group. Owing to the upcoming summer season, customers will be on the lookout to purchase cooling products and we are definite that our offer will help them to buy these products with easy financing schemes."

Speaking on this association with Kissht, Haridas C, Vice President, Sales & Marketing, Blue Star said, "Consumers in the room air conditioners segment are brand-conscious, preferring specialist air conditioning players. This has worked to the advantage of Blue Star since it enjoys the reputation of being a premium and aspirational brand, and its rich pedigree with high quality of product array is well aligned with this image. Blue Star's tie-up with Kissht will further facilitate in availing consumer finance for our products and we are confident of enhancing our market share through this initiative". ■

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United Technologies Appoints CEOs for Carrier and Otis

United Technologies (UTC) announced the appointments of David L Gitlin as President and Chief Executive Officer of Carrier and Judith F Marks as President and Chief Executive Officer of Otis effective immediately.

"I'm pleased to announce these most important assignments as we make strong progress toward our goal of establishing both Carrier and Otis as stand-alone public companies and clear leaders in their respective industries," said Greg Hayes, UTC Chairman & CEO. "I have great confidence in Judy and Dave to drive strategic growth, lead their industries in innovation and customer focus, and maximise value creation for their respective shareowners, customers and employees."

"I'm deeply honoured to join the tremendous team at Carrier. We are the industry's premier intelligent building systems company. As we prepare to become an independent public company, we will be working tirelessly to ensure that we provide best-in-class performance for our customers, employees and shareholders," said Dave Gitlin.

"I'm privileged to lead our 68,000 Otis colleagues into the future. We're the world's leading elevator and escalator company, moving more than two billion people a day. The largest portfolio of service contracts, our global presence, and our ability to execute at scale enable Otis to deliver superior returns to share owners through economic cycles. We continue to differentiate our business through a relentless focus on our customers, unparalleled experience and expertise, a committed workforce, continuous innovation and application of digital technologies across our enterprise," said Judy Marks. ■

SHARP forays into air purification systems in India

SHARP, a provider of air and water purification, consumer durable products, professional displays and office solutions, has forayed into commercial air purification space by launching two new products. With these launches, SHARP aims to expand its foothold in commercial air purification.

The main highlights of the launch are SHARP FU-551K commercial air purifier which is specially designed for commercial spaces such as hospitals, offices, cafeterias and hotels etc. The latest launch uses the similar dual technology of HEPA and Active Carbon filters which is used by its home air purifiers to removes PM2.5 and other gaseous substances while SHARP's owned, developed and award-winning Plasmacluster technology generates fresh air, eliminates toxic fumes, gases, moulds and reduces static electricity providing clear and fresh air. It has 3-way airflow for better coverage.

The coverage area for SHARP FU-551K is 40 square meters and weight only 9.1 kg which is lighter in comparison to other commercial air purifier and can be either mounted on a wall or placed on a shelf. It has 4 operation modes (Full, Max, Medium and Low) and also comes with clean sign indicator apart from dust & odour sensors. Ashish Gupta, Sales Head, Commercial Air Purifiers from SHARP, quoted, "Air pollution significantly impacts productivity. Good indoor air quality plays a vital role in creating a healthy and productive workplace and SHARP's new range of commercial air purification solutions are designed to improve indoor air." ■

Honeywell program to save $4.8 mn for City of Huntington

Honeywell and the City of Huntington, West Virginia, announced the third phase of a 15-year energy savings performance contract (ESPC), which in all three phases is expected to save approximately USD 4.8 million in total operating costs for the city.

This current phase includes a comprehensive LED lighting system upgrade aimed at improving overall energy efficiency and occupant comfort levels, all while helping to reduce maintenance frequency. The LED lighting technology will be complemented with occupancy sensors across portions of the facilities to automatically control the lighting. In addition, HVAC system improvements and a control system upgrade will be made at City Hall. The improvements under this phase are expected to generate approximately USD 112,000 in annual energy and operational savings.

The current project scope will cover 14 buildings, including: City Hall, Big Sandy Superstore Arena, Huntington Police Department, A.D. Lewis Community Center, Fairfield East Community Center, Safety Town, Centennial Fire Station No. 1, Guyandotte Fire Station No. 5, Westmoreland Fire Station No. 8, University Fire Station No. 2, John W. Gallagher Fire Station No. 10, St. Cloud Fire Station No. 4 and the Public Works Department's Traffic Building. This phase of the contract is expected to be completed in September 2019.

"We are focused on bringing energy savings and enhanced comfort levels to Huntington residents and employees through these city facility enhancements," said Wayne Kent, Vice President and General Manager Americas of Honeywell Building Solutions. "Project upgrades, specifically at the Big Sandy Superstore Arena, will help to attract a wider variety of events, while optimizing energy consumption and comfort levels in some of the city's most critical facilities – including the police department and fire stations." ■

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Kylie Farrelley appointed to Refrigerant Reclaim Australia

Refrigerant Reclaim Australia (RRA), the product stewardship organisation for the Australian refrigerants industry, has named Forane business manager Kylie Farrelley as its new general manager.


Kylie Farrelley

Farrelley is taking over from Michael Bennett, who will be stepping down in June after serving the organisation since 1997. Refrigerant Reclaim Australia was formed in 1993 and is the industry-funded not-for-profit organisation established to recover, reclaim and destroy ozone depleting and synthetic greenhouse gas refrigerants.

With near 20 years at previous employer Arkema, Kylie Farrelley brings a wealth of knowledge and experience to her new role. She has been affiliated with Refrigerant Reclaim Australia since 2008 as an industry representative, was appointed to the board of directors in 2016 and became chair last year.

Her primary objectives will be to expand RRA's outreach work, educate the industry and public on the work RRA is doing, and generate a higher return rate of refrigerants in Australia.

Promising to work with the industry to continue to build on RRA's success in reducing harmful emissions and protecting the environment, Farrelley acknowledged the contribution of Michael Bennett. "I would like to acknowledge the exceptional vision of Michael Bennett, whose passion and dedication has built the RRA scheme to what it is today," she said.

Since inception, RRA has taken back more than 7,000 tonnes of used contaminated and unwanted refrigerant. This equates to more than 10 million tonnes of stratospheric ozone being saved from destruction, and more than 14 million tonnes of carbon dioxide equivalent being prevented from emission. ■

Eckhard A Groll named head of Purdue Mechanical Engineering

The Purdue College of Engineering has selected a seasoned leader to be its new head of the School of Mechanical Engineering. On July 1, Eckhard A Groll will become the William E and Florence E Perry, Head of Mechanical Engineering. Currently, Groll serves as associate dean for undergraduate and graduate education for the College of Engineering and the Reilly Professor of Mechanical Engineering. His successor as associate dean will be announced at a later date, said Mung Chiang, the John A Edwardson, Dean of the College of Engineering.


Eckhard A Groll

Groll came to Purdue in 1994 as an assistant professor, moving to associate professor in 2000 and full professor in 2005. He was named a Reilly Professor in 2013. He holds a pre-Diploma of Engineering and Diploma of Engineering, both in mechanical engineering from Ruhr-University of Bochum, Germany. He earned his Doctor of Engineering degree in mechanical engineering from the University of Hanover, Germany.

"I consider it the right time to reinvent the School of Mechanical Engineering as an interdisciplinary, unique entity that provides exceptional cross-disciplinary and transformational learning, discovery, and engagement activities for our students, faculty and staff," Groll said. "I am deeply honored and excited about the opportunity to lead our school." ■

Martin Schulz is the new Head of Sales for Germany at ebm-papst

Martin Schulz has taken over as Head of Sales for Germany at ebm-papst. He will succeed David Kehler, who will take on international responsibility within Sales at ebm-papst in the future.


Martin Schulz

As of June, Martin Schulz will be head of sales for full-coverage sales and as such, responsible for field sales at ebm-papst in Germany. He will report directly to Stefan Brandl, Chief Executive Officer of the ebm-papst Group.

"To our customers, ebm-papst has always been more than just a supplier. Our strengths are understanding our customers and their applications, and working out the best solution on that basis," replied Schulz when asked to describe his new assignment. "From a strong field sales force with direct customer contact and precise technical support from project engineers to customer service representatives who ensure reliable delivery service, ebm-papst is perfectly positioned in this regard. It is the basis for very close partnerships." Schulz formulated his goal accordingly: "Together with our customers, I plan to use this basis to leverage the opportunities inherent in the new digital technology." ■

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Leaders in Gas Phase Filtration Systems

Chemours' John Sworen to be awarded Gordon E Moore Medal

The Society of Chemical Industry (SCI), America Group announced that John Sworen, Technical Fellow at The Chemours Company (Chemours), will be awarded the 2019 SCI Gordon E Moore Medal. The honour recognises his contributions in the research and development of non-fluorinated, renewably sourced durable water repellents for use in the consumer textile market. SCI established the Gordon E Moore Medal to recognise early-career success in innovation.

"Increased demand for renewably sourced products without sacrificing performance durability calls for innovative ideas to deliver a superior product," said Craig A Rogerson, Chairman, President, and CEO of Hexion and Chair of SCI America. "John's work on Zelan or Teflon EcoElite exceeds expectations, delivering a breakthrough technology committed to reducing the environmental footprint of treated fabrics. SCI is pleased to honour John's outstanding work and contribution to science and industry." Sworen led a team that invented the Teflon EcoElite finish, the first renewably sourced, non-fluorinated fabric treatment for durable water repellency and manufactured with 60 per cent renewably sourced raw materials. This means that much of what goes into Teflon EcoElite can be naturally regrown and replaced over time. Simultaneously, its performance far exceeds existing non-fluorinated technologies, such as paraffin and silicones. Unlike those types of non-fluorinated finishes, Teflon EcoElite continues to repel water and water-based stains for 30 washes or more. Other product benefits include that the finish is up to 3x more durable than existing non-fluorinated repellents, maintains fabric breathability for maximum comfort, compatible with common finishing auxiliaries, including resins and cross-linking agents and not made with genetically modified organisms (GMO) or alkylphenol ethoxylate (APEO).

"The world is demanding more sustainable solutions, and John has delivered," said Paul Kirsch, President of Fluoroproducts at Chemours. "His work on Teflon EcoElite has given the textile industry the first-ever non-fluorinated plant-based durable water repellant, which is no small feat. We are so proud that he has received this richly-deserved recognition and can't wait to see what he will discover next," he added.

Sworen will be presented the award at a luncheon in his honor during Innovation Day, hosted jointly by SCI and the Science History Institute (the Institute) on September 10, 2019 at the Institute's headquarters in Philadelphia. ■

Mitsubishi Electric's US Building Solutions Website Receives Effie Award

Mitsubishi Electric Corporation announced that Mitsubishi Electric US, Building Solutions website has received a Bronze award in the business-to-business category (BtoB) of the Effie Awards, an international awards program recognising excellence in advertising. Mitsubishi Electric is the only winner of BtoB category this year, and this is believed to be the first time that a Japanese electronics manufacturer has captured Effie Awards in this category.

The Building Solutions website (buildbettertogether.com) was launched in 2018 to introduce Mitsubishi Electric building solutions and equipment for the US market. As a digital marketing platform, it provides online marketing support in parallel with traditional face-to-face sales activities, using customer purchasing behaviour to help unearth prospective customers and support long-term relationships. Mitsubishi Electric plans to use the website in other global markets besides the United States. The Effie Awards recognise the use of information and communication technology for the ongoing shift to digitally reorganised business-to-business operations. The shift reflects society's transition from tangible to intangible, such as conveying non-traditional value and intuitive expressions using video or computer graphics. The shift also reflects the global spread of smartphones and marketing activities that seamlessly connect online and offline environments, where smartphones serve as the key interface for communications and online marketing in business-to-business operations. The website introduces solutions and equipment in a virtual building that would be the world's tallest if it actually existed. Videos present products and technologies while calculators allow users to learn about estimated running costs, energy savings and so on for each product. Clicks on specific products and other information enable the website to compile general information on customer interests. ■

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Global HVAC Market Expected to Reach USD 136.5 bn by 2024

Global warming, particularly due to greenhouse emission, has led to rise in temperature and has been a major driving force for the rising demand for HVAC systems across the globe.

Global HVAC market is expected to reach USD 136.5 billion by 2024, registering a CAGR of 3.9 per cent during forecast period, according to P&S Intelligence market report.

The market is buoyed by several factors, predominantly increasing government initiative across the globe, coupled with overall growth in the construction sector. Furthermore, rising average global temperature is propelling the year over year (YoY) growth of the market.

Global warming has led to rise in temperature and has been a major driving force for the rising demand for HVAC systems, across the globe. According to NASA's Goddard Institute of Space Studies (GISS), since 1980, the average global temperature increased by 0.5C per year. Additionally, some countries in regions such as Middle East and Africa (MEA) and Asia-Pacific (APAC) experience subtropical and hot climate, resulting in intensely hot and humid summers; thereby, making them heavily dependent on HVAC systems for their cooling requirements.

Insights on market segments

On the basis of HVAC type, the global HVAC market is segmented into heating, ventilation, and cooling, wherein cooling category is further segmented into variable refrigerant flow (VRF), ducted split or packaged unit, split unit, chillers, and room air conditioners (RACs). Of which, split unit system accounted for the largest revenue share in 2018. Increasing preference toward ductless air conditioning systems have been one of the major drivers for its growth. Commercial and residential were the prime sectors for continued demand in HVAC systems. As of 2018, more than 60 per cent of the US households are estimated to have deployed central air conditioning system.

On the basis of end-user type, the market is segmented into commercial, industrial and residential, wherein industrial is further segmented into food and beverage (F&B), automotive, energy and utilities, and oil and gas. Of these categories, food and beverage category recorded highest revenue share in the industrial HVAC market in 2018. F&B manufacturing unit requires properly designed air handling system to control airborne particulates and odours. Whereby the system isolates food from outdoor airborne contamination infectious pathogens like Salmonella, Listeria, and E. coli. Further, strict guidelines from agencies such as Food Safety Modernisation Act (FSMA) lead to renovations or expansions in the F&B sector in US.

In 2017, around 640 food and beverage manufacturing units underwent renovations and expansionary projects including 63 new brewery manufacturing units. Countries such as US are witnessing increasing consumer demand from F&B sector. During 2018-2021, consumption of F&B is projected for a growth of 11.3 per cent in North America region.

North America region has been one of the largest consumers of HVAC system. The region exhibits very high temperature during peak summer, where the use of these systems becomes a critical need. Further, populace in the region has a high purchasing power parity (PPP), wherein according to the statistics provided by the World Bank, the US, and Canada recorded annual per capita income of USD 59,531.6 and USD 45,032.1 in 2017. In commercial buildings, HVAC system consumes 40 per cent of the total power consumption. The OEMs in the market are investing in launching new and innovative products, in order to increase the efficiency level of HVAC systems. For instance, in July 2018, Carrier and Toshiba entered into a partnership and launched energy efficient air conditioning solution 'Hi-wall' air conditioner. It aims to reduce energy consumption by 40 per cent as compared to 3-Star AC and can save up to USD 725 over a period of five years. The regions including APAC, US and MEA are highly adopting technologies, which includes district cooling and solar refrigerant systems. Some of the major players in the global HVAC market include Johnson Controls International PLC, Samsung Electronics Co, Lennox International, Ingersoll-Rand, United Technologies Corporation, Daikin Industries, Mitsubishi Electric Corporation, Toshiba Carrier Corporation, LG Electronics, Fujitsu Limited, Midea Group, Gree Electric Appliances, Inc. of Zhuhai, and Danfoss A/S. ■

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Top HVACR Products 2019

Innovative technologies and products are taking the world by storm and HVACR industry is not an exemption. *Cooling India* brings you some of the advanced solutions that are all set to create waves in HVACR industry.

Smart Belimo Energy Valve for Coil Energy Measurement

Belimo Energy Valve is an Internet of Things (IoT) device – a smart connected pressure-independent valve that measures and manages coil energy consumption by utilising an embedded flow meter, along with supply and return water temperature sensors. The valve also has power control and Delta T Manager logics built-in that monitor coil performance and optimise the heat transfer of the coil by maintaining the Delta T.

Features

- **Optimisation of Delta T and Flow Settings:** Cloud Analytics offers recommended Delta T settings by Belimo experts for efficient operation. System performance and stability are improved.
- **Performance Report:** Belimo Cloud Reporting permits a complete overview of the current and previous performance data such as flows, energy consumption, power requirements and Delta T.
- **Lifetime Data Access:** The Belimo Cloud stores the entire history of the Belimo Energy Valve and its operating data in one location. The online database forms the basis for future operation optimisation.

Applications

Belimo Energy Valve finds applications in chillers, AHUs, FCUs and TFA.

Market Potential

The company envisages a growing demand for technology-based products where customers look at newer ways to enhance energy savings and achieving the conditions at optimum levels.

Belimo Energy Valve

Testo 400

Testo Smart Probes for on-site data recording

Testo has been one of the market leaders in testing and measurement equipment, especially, providing a wide range of smart HVACR products that equip the users with smart and easy measurement techniques using the smartphone interface.

TestoSmart Probes are small pocket-sized intuitive measuring instrument that are best suited for on-site data recording and report generation on smartphones. Testo 420 air capture hood for measuring the air volume flow has made the measurements easier even at the turbulent inlets or outlets. Testo has a range of electronic refrigeration manifolds or analysers that not only helps to measure pressure but also calculates accurately the sub-cooling and superheating temperatures based on the refrigerants selected. Testo also has digital vacuum measuring instrument like testo 552 for the evacuation of refrigeration or air conditioning systems and heat pumps. Testo 440, intuitive air velocity and IAQ measuring instrument can carry out measuring tasks on air conditioning and ventilation systems.

The new testo 400 is the universal measuring instrument for all air flow and IAQ applications, and impresses with smart technology.

Features

- The universal testo 400 is not just smarter, faster and better – it is also seamlessly integrated into Testo's comprehensive IAQ range.
- It not only records or displays the data but even assists in report generation, measurement process and record live measurement images.
- The range of probes for the new measuring instrument is among the broadest on the market which is compatible with a wide selection of Bluetooth and wired probes, as well as testo Smart Probes and testo 440 probes.
- Can measure °C, %RH, CO, CO_2, m/s, Lux, hPa.
- 5-inch HD touch display with 1280 x 720 px resolution.
- Convenient smart touch operation with front and rear camera to capture live images.
- Intelligent calibration concept with HD graphic display.
- HVAC grid measurement in accordance with EN ISO 12599 and ASHRAE 111.

Applications

Testo 400 find its application in almost all IAQ and air velocity measurements in the field of air conditioning and ventilation. Air flow measurements can be conducted in the ventilation ducts, at air outlets and on filters. Measurements in laboratories and cleanrooms is yet another application where testo 400 can be used for flow measurements in fume cupboards, differential pressure measurements and laminar flow measurements in cleanrooms, humidity measurements in cleanrooms etc.

Market Potential

Testo 400 is probably the best suited product for HVAC consultants, contractors, advisors, building surveyors and etc who work in precision and comfort level monitoring in large working areas.

Filter driers with fluorescent dye

Dry All introduces world's first trailblazing technology

Dry All's understanding of products like oil separators, accumulators, receiver, filter driers, heat exchangers etc has helped to introduce the world's first trailblazing technology 'Filter Driers with Fluorescent Dye'. This technology has helped HVACR OEMs and contractors to detect the exact source of refrigeration leak. Tracer Wafer (TW) (manufactured by Spectroline-USA) charged with fluorescent dye is placed along with the desiccant. When the system starts and the TW meets refrigerant and oil, the dye in the wafer is released and circulates with the refrigerant. In case of a leak, dye escapes leaving a mark at the point of the leak. The exact point of a leak is easily visible under a UV light through yellow glasses. This dye is compatible with all refrigerants and oil.

Features

- Quickly finds the exact source of small, multiple and intermittent leaks in HVACR system.
- Ideal for preventive maintenance and diagnostics.
- This method saves labour, money and downtime.
- Conserves expensive refrigerant and fluids.

Applications

The technology can be used in all HVACR system including air conditioning, refrigeration, chiller, heat pumps etc.

Market Potential

This technology has a potential to be a game changer in the HVACR industry and can replace all other conventional filter drier technologies being currently used.

Embraco's FMX technology for refrigerators

FMX - Technology

Embraco solutions that are differentiated by low energy consumption and allow natural refrigerants usage are focused on energy efficiency. Embraco envisages a huge potential market to its variable speed technology - FMX - for household fridges in India. FMX is one of the solutions with variable speed (inverter technology) that is delivering those features, besides being a bugless solution, a very relevant feature in India. It is a compact product for commercial and household refrigerators that allows natural refrigerant (R600a, isobutane) which has been certified and approved by VDE Institute with a 25-year lifetime.

For commercial, Embraco is presenting FMF line up, the most efficient compressors for the commercial segment available in its capacity range, which has the potential to reduce energy consumption by up to 30 percent when compared to traditional solutions available in the market and is ideal for light commercial applications such as reach-ins and supermarket islands.

Features

- The FMF portfolio is present in markets all over the world.
- More convenience to the consumer through variable speed technology.
- Ideal food and beverage as requisite temperatures are quickly attained, providing fresher food.
- FMF line-up can reach a share in Indian commercial segment in applications such as reach in, glass door merchandiser, bottle cooler and refrigerated islands.

Applications

Embraco also bets in large formats portfolio, such as scroll solution, developed for milk coolers and cold rooms in the supermarkets, convenience stores, restaurants, bakeries and hotels. It's a new range of compressors for commercial refrigeration which offers excellent cooling performance, reliability and efficiency from 2 HP up to 13 HP applications. Compatible with multiple refrigerants (currently R134a, R404A, R449A and R452A), Scroll features a compact, lightweight and sound-insulated design and its tubes and connections are engineered to be compatible with the most popular scroll installations on the market.

ColdChain SmarTrucks

DHL SmarTrucking for real-time visibility of temperature

DHL SmarTrucking Cold Chain integrates technology with trucking to provide world-class temperature-control capabilities and fast transit. With digital sensors for 'Uniform Temperature Distribution Monitoring', DHL SmarTrucking provides 24x7 real-time visibility of temperature and location. From pharmaceuticals to meat and poultry, Cold Chain SmarTrucks can transport a diverse range of products where non-contamination and zero degradation are the rules, and not the exception.

Features

- 95 per cent on-time delivery assurance.
- Up to 30 per cent reduction in transit times compared to traditional trucking.
- Wide temperature range in the range of (-) 25C to (+) 25C.
- Fully compliant with FSSAI (Food and Safety Standards Authority of India) standards for cold chain.
- Emergency reefer power backup.
- High security posture across highways including a quick response emergency team.
- Anti-DEPS (damage, excess, pilferage, shortage) measures to safeguard the shipment.
- Three digital sensors for 24x7 consignment temperature monitoring.
- Provision for offline data logger to facilitate secure monitoring of shipment temperature and location by the customer.
- Onboard diagnostics for preventive maintenance and driver monitoring.
- Door sensors to maintain security of the cargo.
- Fully validated container with thermal mapping and water leakage testing.
- T-section flooring for uniform temperature distribution.
- Herbal foam wash after every trip for maximum hygiene and non-contamination.
- Strip curtains and hatch to maintain temperature and cargo integrity on multi-point deliveries.
- Geo-mapping and route optimisation for efficient operations.
- Driver training and temperature management certification by refrigeration partner.

Applications

DHL SmarTrucking ColdChain is equipped to handle products including frozen food, chilled food and beverages, processed or packaged food, active pharma ingredients, formulations, medication, therapeutic goods, biologics, medical components, life-saving drugs, fragile equipment, and gaseous equipment.

Market Potential

DHL SmarTrucking ColdChain provides panIndia refrigerated trucking solutions to businesses, offering the fastest transit times, ease of use and end-to-end consignment visibility. As a value partner, rather than a service provider, DHL SmarTrucking ColdChain helps businesses provide value to their customers by supporting their business vision and enabling them to concentrate on their core competencies.

CET Enviro's ACCS & SBR


ACCS

CET Enviro has introduced a range of innovative energy and water efficiency technologies that have been researched and developed in state of Israel for optimising and maintaining the heat transfer performance in large scale cooling systems such as water-cooled chillers, commercial HVAC, cooling tower, commercial buildings, industries, power plants, and oil and gas industries.

CET Enviro's signature products include Automatic Condenser (Tube) Cleaning System (ACCS) and non-chemical treatment of cooling tower water Scale and Bio Remover (SBR).

Features

- ACCS is ball-based permanent on-line solution that uses unique hydro-mechanical cleaning system, which operates continuously to keep heat exchanger surfaces completely free from fouling. This helps to maintain the operating capacity and efficiency constantly at peak operating levels.As a result, the chiller works at its top performance.
- This technology also helps to prevent the periodic shutdown as the ACCS keeps the chiller tubes clean 24X7.
- ACCS extends the life of chiller and condenser by preventing corrosion without damaging the internal tubes. ACCS optimises heat transfer performance and reduces chiller electricity consumption by as much as 30 per cent.
- SBR is a non-chemical-based treatment of cooling tower water. The innovative SBR deploys an electrolysis reaction to improve the quality of cooling tower water. SBR controls fouling, scaling and corrosion, while eliminating the use of chemicals. SBR can double or even triple the cycles of concentration (COC), thus, reducing the blow down by as much as 66 per cent by working at higher conductivity.
- This system drastically saves water consumption in the cooling towers.
- Both products are green and have an edge to save energy and natural resources without using chemicals. ACCS reduces electricity consumption by up to 30 per cent and SBR reduces water consumption by up to 66 per cent.

Applications

ACCS and SBR are designed for large scale cooling systems such as water-cooled chillers, commercial HVAC, cooling tower in commercial buildings, industries, power plants, oil and gas industries.

Market Potential

The growing need for energy and water saving initiatives for improving operational efficiency in large cooling system in commercial and industrial spaces drives the market for ACCS and non-chemical cooling tower treatment for SBR.

Self-repairable High-Speed Doors from Gandhi Automations

Gandhi Automations' high-speed freezer doors enable energy and cost savings as well as optimised traffic flows, production and logistic activities. The company innovated the technology by creating High Speed Vertical doors that are self-repairable, fast, safe, reliable and a perfect solution for cold storage with negative temperatures to as low as (–) 22F.

High-Speed Freezer Duo not only helps maintain temperature but also ensures human safety. They have a revolutionary soft bottom edge and sensor combine to ensure operator safety at all times. These 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 openandclose operation has blower or dryer to maintain temperature balance.

Features

Gandhi Automations claims that their High-Speed Freezer Duo has industry's highest operating speed, saves energy, increase refrigeration efficiency, reduce frost, save costs, extremely safe, long lifetime, conform to EN13241-1, and structure in stainless steel optional.

Application

Prime Freeze High Speed Doors are a perfect solution where cold storage with negative temperatures to as low as (–) 30 C

Extech IR320 for temperature diagnostic

Extech Instruments, a FLIR company, is one of the largest manufacturers of HVAC instruments. Extech has various instruments specifically for HVAC industry such as anemometers, borescopes, IAQ meters, environmental meters, electrical testers and many others. FLIR Test and Measurement instrument offers innovative selection of moisture meters, thermal imagers and test and measurement instruments for HVAC industry.

Extech IR320 is rugged, dual laser thermometer that can accurately measure temperature up to 650C. It is suitable for HVAC maintenance technicians and contractors for temperature diagnostic of HVAC and refrigeration systems, electrical and mechanical systems.

Compact environmental series Extech EN510, AN510 and RHT510 is specifically useful for HVAC and IAQ professionals. EN510 10-in-1 Environmental Meter that measures or calculates air velocity, air flow, air temperature, bead probe (Type K) temperature, heat index, humidity, wet bulb, dew point, wind-chill, and light level. This multi-function meter solves need for different instruments for single parameters. AN510 CFM or CMM Anemometer with Thermometer is 4-in-1 Anemometer that measures air velocity, air flow, air temperature and Type K Temperature. The AN510 helps HVACR technicians troubleshoot problems such as hot and cold spots in a residential or commercial space; pressure imbalances; leaky ducts with little to no airflow. RHT510 Hygro-Thermometer and Psychrometer measures relative humidity, temperature, dew point, and wet bulb. IAQ professionals can use dew points to target window condensation. Dew Point measurements are ideal for controlling indoor humidity.

New Extech moisture meter MO53 with integrated sensor and MO57 with external spherical sensor are pinless moisture meters. The MO57's spherical probe design can be used to access deep into corners, under carpets, along ceilings and other difficult to reach locations.

Extech IR320

Features

- IR320 is made considering tough conditions on site. Even if the instrument falls from height it can withstand nearly 10 feet (3m) drop. IR320 comes with ingress protection rating of IP65 that makes it dust and water proof so that it can easily handle rainy outdoors and water intensive manufacturing processes.
- New Extech moisture meter MO53 takes reading without damaging the surface with the depth of approximately less than 4" (100mm) in case of MO57 and approximatelyless than 0.75" (20mm) with MO53.

Applications

Extech IR320 is suitable for HVAC maintenance technicians and contractors for temperature diagnostic of HVAC and refrigeration systems.The new moisture meters can be used to measure moisture in wood (up to 99.9 per cent) as well as other building materials (MO57: 99.9 per cent; MO53: 56.5 per cent) such as wall board, sheetrock, plaster, mortar, concrete as well as tiles (using the MO57).

Prime Freezer Doors

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

Market Potential

The industry is moving towards increasingly sophisticated entrance automation solutions like high speed doors, automated rolling shutters, loading bay solutions, sectional overhead doors etc. driven by demand from key user segments such as cold storage, pharmaceutical, food, poultry, dairy, horticulture, floriculture, construction, industrialisation etc. Gandhi Automations' solutions cater to wide variety of customers ranging from large beverage manufacturing corporates to cold storages operating in retail markets, and every requirement is unique.

ABB's ACH580 variable speed drives for comfortable climate

ACH580 Variable Speed Drives

ABB's energy-efficient ACH580 variable speed drives help ensure a comfortable indoor climate and fresh air.

Features

- Provides comfort control with variable speed drives that ensure reliable and effortless operation of HVAC applications.
- The new ACH580 series of variable frequency drives (VFDs) provide the quality, reliability, and energy savings, and are easy to use and safe to maintain. All you need to do is to set the drive up, and then focus on what counts.
- Easy to select, install, commission and use. It has reliable connectivity with major automation and control systems having intuitive control panel with optional bluetooth capability for better accessibility.
- Has optimised energy efficiency and wide availability and support.

Mitsubishi Electric Trane's SLZ-KF 4-Way Ceiling Cassette

Mitsubishi Electric Trane HVAC US (METUS), a provider of Zoned Comfort Solutions and one of the leading suppliers of Variable Refrigerant Flow (VRF) heating and cooling systems, introduces the SLZ-KF Four-way Ceiling Cassette for residential installations.

The new SLZ-KF Four-way Ceiling Cassette, part of the M-Series product line from METUS, is designed to provide the utmost comfort to homeowners. Available in 9,000, 12,000, 15,000 and a newly introduced 18,000 BTUH size.

Features

- The unit offers flexible airflow with two, three or four-way vane control which allows homeowners to personalise their settings. If applied with the optional 3D i-see Sensor, the unit further customises heating and cooling through the sensor's ability to read a room's thermal profile to calculate the occupancy rate.
- With the 3D i-see Sensor, direct and indirect airflow settings can be selected to offer 72 different combinations for vane direction and individual vane adjustment.
- The SLZ-KF automatically adjusts conditioning based on the heat signatures detected in the space and can switch into setback mode when the room is unoccupied.
- Monitoring a room's occupancy results in even temperature distribution and a more energy-efficient operation for homeowners.
- The SLZ-KF Four-way Ceiling Cassette has a Seasonal Energy Efficiency Ratio (SEER) of over 19.8. This is well over the US minimum SEER requirement of 13 and can translate to cost savings on users' heating and cooling bills.
- Additionally, the SLZ-KF offers a Heating Seasonal Performance Factor (HSPF) rating of 11.2 or more, which is a marked improvement in energy-saving performance as compared to previous models.

Applications

Apart from promoting sustainability through energy efficiency, the ceiling cassette helps to better the environment within a home through improved indoor air quality and reduced operating noise. The SLZ-KF Four-way Ceiling Cassette includes an easy-to-clean washable air filter with multi-stage allergen filtration to reduce dust and debris circulation.

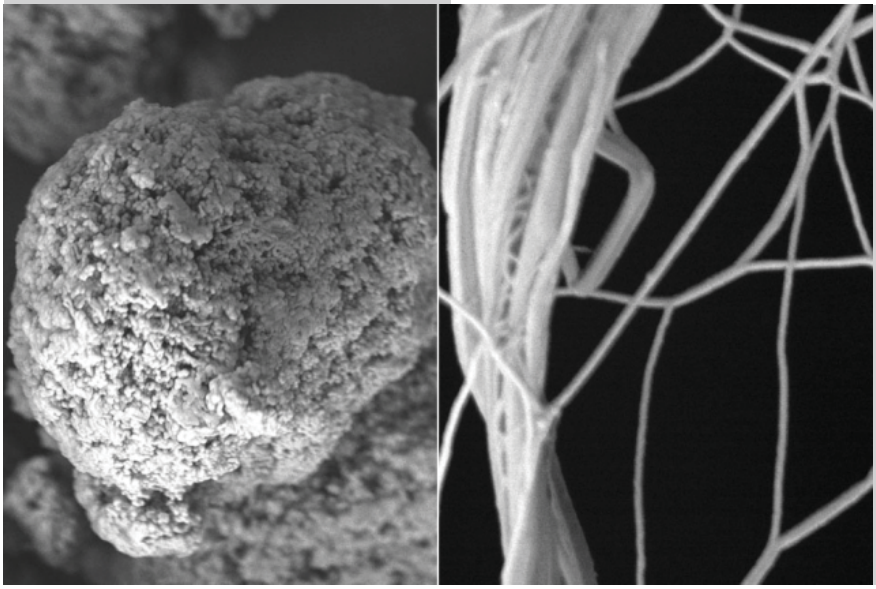
New polymer films conduct heat instead of trapping it

Polymers are usually the go-to material for thermal insulation. Think of a silicone oven mitt, or a Styrofoam coffee cup, both manufactured from polymer materials that are excellent at trapping heat.

Now MIT engineers have flipped the picture of the standard polymer insulator, by fabricating thin polymer films that conduct heat — an ability normally associated with metals. In experiments, they found the films, which are thinner than plastic wrap, conduct heat better than ceramics and many metals, including steel.

The team's results may spur the development of polymer insulators as lightweight, flexible, and corrosion-resistant alternatives to traditional metal heat conductors, for applications ranging from heat dissipating materials in laptops and cellphones, to cooling elements in cars and refrigerators.

"We think this result is a step to stimulate the field," says Gang Chen, the Carl Richard Soderberg Professor of Power Engineering at MIT, and a senior co-author on the paper. "Our bigger vision is, these properties of polymers can create new applications and perhaps new industries, and may replace metals as heat exchangers."



By mixing polymer powder in solution to generate a film that they then stretched, MIT researchers have changed polyethylene's microstructure, from spaghetti-like clumps of molecular chains (left), to straighter strands (right), allowing heat to conduct through the polymer, better than most metals.

Schneider Electric's EcoStruxure Building Operation

EcoStruxure Building Operation (formerly SmartStruxure) is an open building management platform that integrates multiple systems for centralised, real-time control and management across one to many enterprise buildings.

EcoStruxure Building Operation delivers the actionable insights needed to better manage and optimise buildings, improve engineering efficiency, and meet increased cybersecurity and compliance needs.

Features

- Native, open standards protocols for interoperability.
- Engineering efficient architecture.
- Integrate electrical, life safety and other equipment.
- Customised alarms and alerts.
- Dashboards and applications for energy management, trending, scheduling, equipment, reporting, FDD and more.
- User friendly navigation and customisation.
- Centralised management of building portfolio.

Applications

- Multi-system integration platform
- HVAC Control
- Lighting Control
- Power Monitoring
- Energy Management
- Curtailment
- Equipment alarms and alerts
- Real-time Analytics and Reporting
- Benchmarking. ■

(Disclaimer: This list is not exhaustive and only includes some of the recent solutions)

PRIHODA: Global Brand of Innovation

Transforming Ducting Industry in India

Prihoda s.r.o had invested quality time since 2015 in Indian market to understand the market needs, applications and operational challenges etc.

Ulhas Keshavsingh Vatpal,
Director, Prihoda India Pvt Ltd

For over 25 years, Czech company Prihoda has been providing engineered fabric ducting and air distribution solutions to commercial and industrial HVAC applications around the world. The company made its entry in Indian market last year and gaining momentum since then. In an interview with Cooling India, Prihoda India's Director Ulhas Keshavsingh Vatpal talks about what makes Prihoda fabric ducts unique. Excerpts:

From a humble beginning in 1994, Prihoda has become a global providers of fabric ducting and diffusers, designed for transport or distribution of air. Could you brief us on your business activities in India?

We are a medium-large Czech company manufacturing first-class textile ducting and diffusers for air transportation and distribution. We do not manufacture ducting by the meter but provide custom-made solutions. Our work is based on high technical quality and knowledge of airflow. Our company is in the small industrial city of Hlinsko in the middle of the Czechia. From there, and from our subsidiaries in China and Mexico, we send our products to more than 70 countries across the world. We work closely with a network of trained sales agents, who are part of the unit called the "Příhoda Family". The company, which was established in 1994, is still owned and managed by its founder Zdeněk Příhoda.

Prihoda s.r.o had invested quality time since 2015 in Indian market to understand the market needs, applications and operational challenges etc. After clear understanding they decided to have dedicated office in India to serve the local market in a better way and established Prihoda India on 24th May 2018 in India having head office at Kharghar, Navi Mumbai.

We deliver over 6,000 projects worldwide every year and 99 per cent of these contracts leave on the exact deadline. We work with professional transportation companies and we monitor the consignment until it is delivered to the customer.

Prihoda products are usually acting as both supply air ducting (air transfer) as well as air distribution or diffusion into the occupied zone. We supply both types of system: Positive pressure distribution systems (supply air), and Negative pressure (extract/return air) ducting for exhausting air from rooms.

What about insulation and condensation issues in fabric ducts?

We have around 15 types of fabric and most of the fabrics does not require insulation. Use of permeable fabric eliminates the risk of water condensation on the surface of the ducting and our ducting comes with incorporate insulation inbuilt. We use permeable materials to avoid condensation where supply air temperature is below dew point. However, we only have material of a single permeability value. It is very low and serves just to prevent condensation. Distribution of air is done exclusively using holes (perforation or micro perforation or a combination of both) and adjusted holes (nozzles, pockets). Our product portfolio also includes non-permeable materials, which are often useful in other situations.

Can fabric ducts withstand fire?

We have fabrics with fire resistance properties with Class A, Class B, Class C. Suitable fabric can be used according to use of application. Our unique materials are certified for fire resistance in accordance with EN 13501-1 (in various classes depending on materials) and the American UL 723. Our company has a certified quality management system in accordance with ISO 9001 and an environmental management system in accordance with ISO 14001. Prihoda's fabric diffusers also obtained an Oeko-Tex certificate. The PMI/NMI/PMS/NMS fabrics are certified to European standard EN 13501-1 with excellent results. In this test our fabrics achieve B-s1, d0 classification, which means prevention of spread of fire, minimum smoke production and no burning drops. Glass (NHE) fabrics in fact meet Class A requirements: Classic, Premium and Recycled.

How hygienic are your fabric ducts?

Our textile ducts are only ducting system that can be thoroughly cleaned by washing with an optional use of a disinfection, addition to that our textile duct also comes with Anti-bacterial coating. We utilise a special treatment which guarantees that no bacteria can survive if settled on to our fabric Premium (PMI/NMI) and Durable (NMR). This treatment remains effective after multiple washing. Tests for the European Standards found that after 10 washes there was no reduction in the efficacy of the treatment. This allows us to offer up to 10 years warranty on the basis of our minimal maintenance requirements.

How cost effective are fabric ducts than traditional GI ducting?

The traditional ducting comes with GI sheets, grills, diffusers, insulations, dampers, branching etc. All these can be addressed more effectively with our fabric ducting by comprising all with CFD analysis. Transportation is also comparatively cheap thanks to the low weight of our products and the fact that they can be folded into small boxes.

What is the typical area of application for fabric ducts?

Applications compile of vast area and fields (all indoor) including food, engineering, automotive, chemical and textile industries, warehouses, schools, restaurants, temporary installations, freezing plants, kitchens, sport facilities, fitness centres, swimming pools, supermarkets, cinemas, theatres, TV studios, offices, laboratories, hospitals, clean areas, greenhouses, painting shops, transportation vehicles, stables, chicken hatcheries etc.

What is the installation time and mounting material required?

Our fabric ducting is very easy to install as compare to traditional ducting. All mounting materials are provided along with fabric ducting. Easy representations on YouTube videos and training makes our installer relax and complete the work in stipulated time frame. We can save the overall installation time up to 50 per cent.

What is the Prihoda Art Technology?

Our fabric Prihoda Art Technology gives our textile diffusers a new aesthetic dimension. They can become an interesting part of every interior. We can produce fabric diffusers and air ducting in any Pantone colour, with any pattern, photograph, picture, logo or sign, regardless of how complex they are. Its art and science together in our fabric ducting technology.

What about your unique software for designing the ducting?

Our team of experienced Engineers use in-house customised Air Tailor software which comprises of AutoCAD, Revit and CFD tools to create a custom-made design for air distribution according to the customer's wishes and the layout of the area. We easily consider unusual requirements a challenge and we propose our product as a solution on those. This helps us to provide Air flow profiles, sound level details and exact view of ducting for better understanding.

How durable are the fabric ducts?

Our textile ducts are available in both permeable and non-permeable options, suitable fabric can be selected depending upon humidity and RH content of surrounding. Our textile ducts are with up to 10 years warranty on fabric material and are washable. The fabric ducting and diffusers can be cleaned perfectly by laundering in a washing machine. The frequency of maintenance depends on the environment and on local hygiene standards. We have executed a detailed procedure for washing and cleaning the diffusers and can recommend suitable products on request. ■

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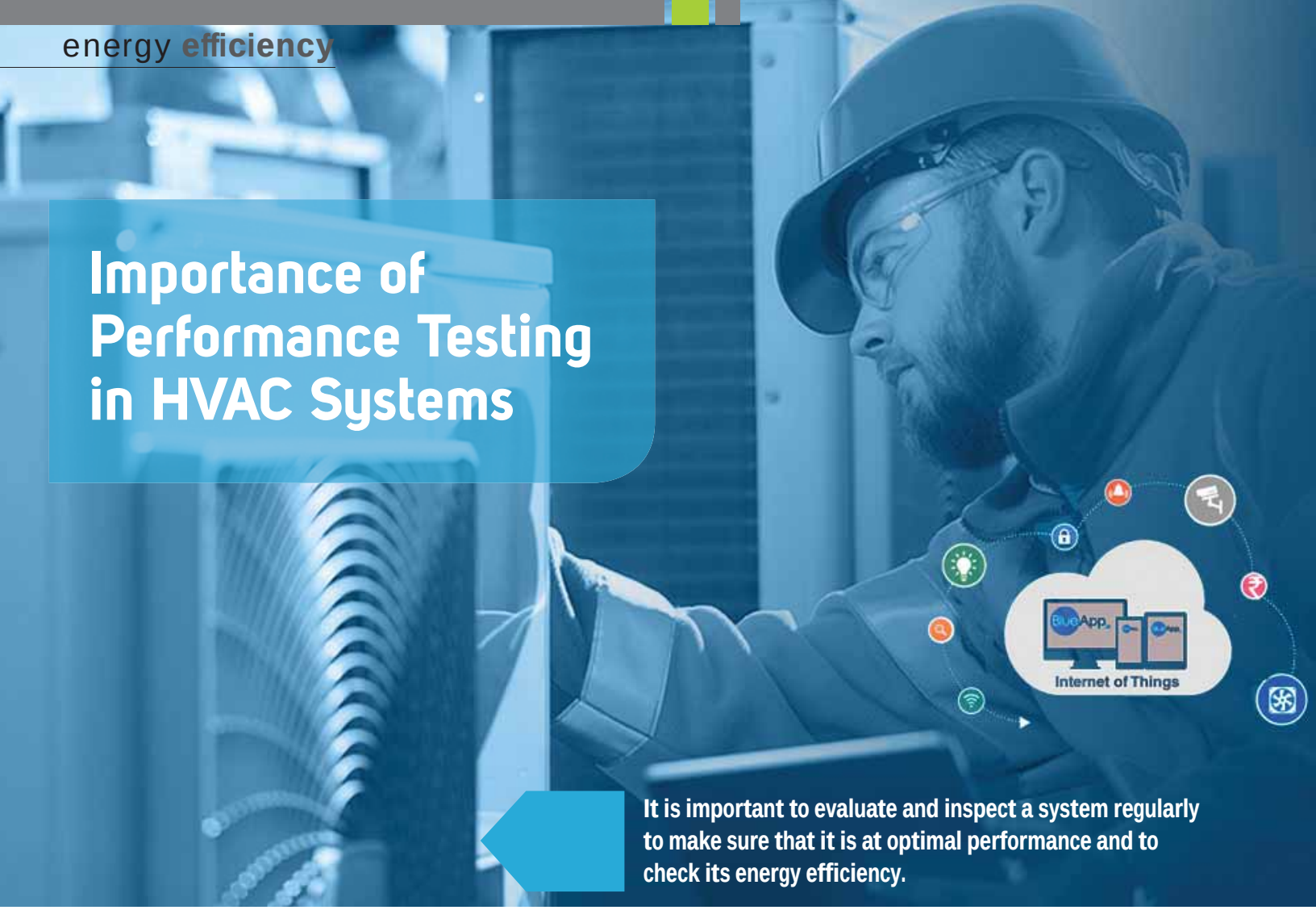
Importance of Performance Testing in HVAC Systems



It is important to evaluate and inspect a system regularly to make sure that it is at optimal performance and to check its energy efficiency.

Optimal and energy efficient performance is a factor of serious concern in present scenario of IoT and AI related with HVAC. It is important to evaluate and inspect a system regularly to make sure that it is at optimal performance and to check its energy efficiency. Undoubtedly, HVAC systems are no exception to this rule. Now that fall is around the corner, it is a good time for homeowners in Lufkin, Texas, to have performance testing done on their HVAC systems. Performance testing is vital for finding problems HVAC system may have developed over the summer.

Performance Testing for HVAC Systems

Testing, adjusting and balancing (TAB) is necessary to confirm that an HVAC system is performing optimally to offer occupants with the most comfort at the lowest cost. Different performance tests evaluate different functions of an HVAC system. Here are some of the performance tests user should regularly and periodically conduct for his or her HVAC system:

- **Energy Efficiency Testing:** An energy efficiency test will check an HVAC system to make sure that energy usage is as low as possible without hindering maximum comfort of the occupant. If energy bills are too high, user may want to order an energy efficiency test.
- **Acoustical and Airflow Testing:** The acoustical and airflow test will check the airflow within home to determine whether HVAC system is performing optimally.
- **Air Cleaner Testing:** HVAC system cleanses the air to keep indoor air quality ideal. Homeowners who have young children with asthma should have a test performed to evaluate the effectiveness of their system's air filter or cleaner.

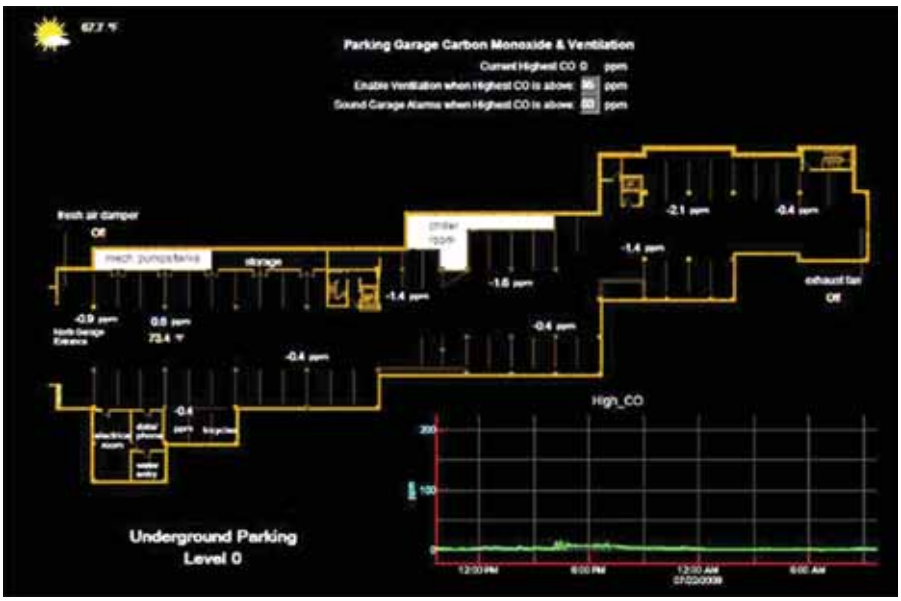
Importance of Performance Testing

Performance testing allows homeowners to identify issues with their HVAC systems. That way, homeowners will be able to have these issues resolved before they get worse and costlier to repair. For example, if the user's air conditioner is inefficient when it comes to cleansing the air, even if the user changes the filter, it may suggest a more serious problem. Performance testing allows homeowners to deal with issues while they are small and easy to repair.

In preparation for the winter, user should have performance testing done for HVAC system. For more information about performance testing, user should not hesitate to contact a skilled technician.

Functional Performance Testing of HVAC System

Functional Performance Testing (FPT) is the process of putting the Direct Digital Control (DDC) IIoT system through its paces by



DDC Screen Shot - Parking Garage Ventilation showing how are Functional Performance Tests Created.

manipulating every possible condition the HVAC controls and equipment will ever experience. FPT is an important part of the building commissioning process. Only by testing how the DDC system controls respond to switching from cooling to heating or economiser mode, occupied to unoccupied mode, satisfied to unsatisfied temperatures, or normal power to emergency power, can the building owner know the system will function properly when the contractors leave and the building is handed over. The tests force user to work through the controls sequence language created by the design engineer in a sequential order. As the author gains experience as a commissioning engineer, FPT allows him to better understand the brains behind why equipment performs and reacts as it does. To make sure, a piece of equipment works as intended and can provide the expected performance is the main reason to functionally test HVAC systems.

Depending on how the building is used and what the building owner wants, the control sequences can vary significantly among different types of buildings. For example, an office building is going to have different operating hours than a hotel and a warehouse is going to have different comfort requirements than an office. In addition, all buildings will have different sequences depending on the system types and specific equipment chosen by the engineer and owner (e.g., rooftop units versus heat pumps, central plant versus stand-alone equipment).

The tests are created by using a workflow diagram: start with the systems running and change setpoints or fail components to see how the system responds. Does the backup pump turn on when the user manually disconnects the main pump? Does the chiller turn off when the user manually overwrites the water temperature below the chiller setpoint? Does the emergency power turn on all of the equipment if the building experiences a power failure? The tests are written to walk through the design engineer's controls sequences step by step and ensure the components are responding as designed.

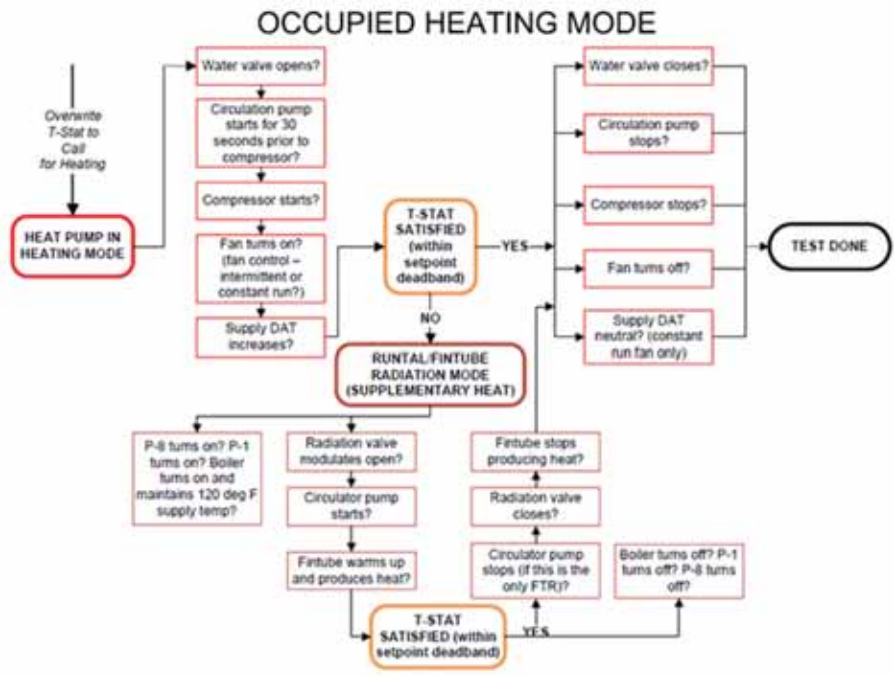
How FPT can call attention to and fix issues?

When user starts picking apart the control sequences to create these tests and then performs the tests in the field, there is a lot of opportunity to find potential issues that could affect the overall performance of a system. The issues can vary in severity, from a small change in the programming of the system, to a larger scale item in which a piece of equipment or component can't perform the way it was intended.

Here are few examples of issues and possible repercussions that were found during the recent functional performance testing of an office building.

Issue: An exhaust fan sensor wasn't working correctly and prevented the fan from turning on when intended. The sensor was fixed and the equipment was retested successfully.

Repercussion: The fan wouldn't turn ON, therefore, inhibiting air from being exhausted out of the space.



FPT Flowchart example for Occupied Heating Mode of a Heat Pump.

Energy improvements can substantially influence 43 per cent of the energy footprint of typical commercial office building.

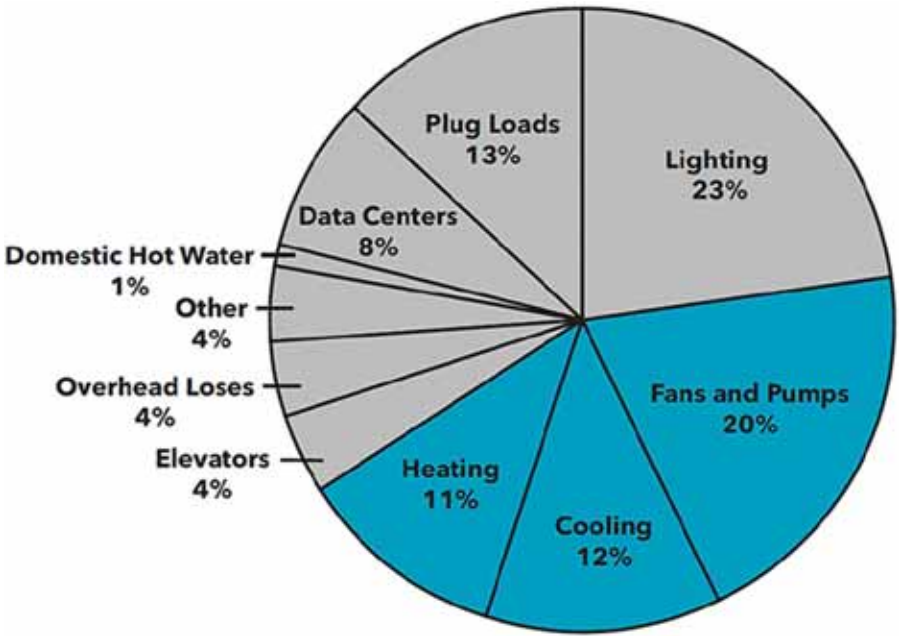


Image 1: Typical commercial office building energy use
(Images courtesy of Bell & Gossett)

Issue: The CO2 sensors, which control the amount of fresh air from being provided into spaces, were not calibrated correctly and were reading very high false levels. The sensors were fixed in these spaces to read more accurate CO2 levels.

Repercussion: The heat pumps and energy recovery units were operating unnecessarily to provide fresh air to unoccupied spaces. Any energy savings attributable to the CO2 sensors were not being realised.

Issue: The pumps for the ground sources system were starting up when any heat pump in the building started, even through the building loop temperature was within its proper range and not temperature conditioning was required. The controls sequence was reprogrammed and retested successfully.

Repercussion: The pumps were turning on unnecessarily, therefore, decreasing the lifetime of the equipment and increasing energy consumption.

If functional testing isn't performed, issues such as the examples above may have never been noticed. All system types can generate different issues and functional performance testing offers reassurance to the building owner that the systems are working correctly and as intended.

Testing HVAC System Efficiency

The Energy Improvement Project consists of three primary steps: conducting an initial energy assessment of the hydronic system, updating the system with technologically advanced pumps and controls and adjusting the system in real time to evaluate the effects of the HVAC modifications.

The impact of energy efficiency improvements is often difficult to demonstrate at the individual system level because buildings typically get billed for energy use at the building level. According to Luke Falk, Assistant Vice President at Related and an adjunct Professor at Columbia University, the partnership among the water technology company, building manager and Columbia University allowed stakeholders to gain a granular understanding of exactly how much energy they would save by implementing a complex HVAC enhancement.

The key finding from the testing was that right-sized pumps paired with variable frequency drives (VFDs) powering the chilled water portion of a hydraulically balanced system can deliver a 95 per cent reduction in pumping energy, far exceeding the team's expectations.

As noted by the Columbia research team, "The pumping electricity reduction with VFDs was far more significant than

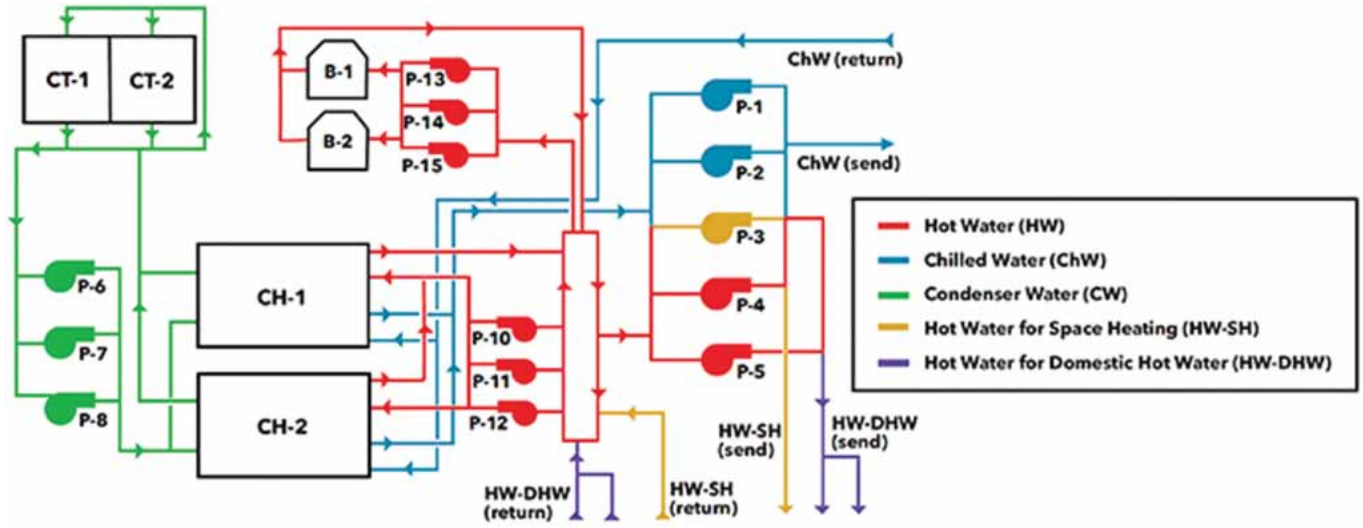


Image 2: Original system schematic

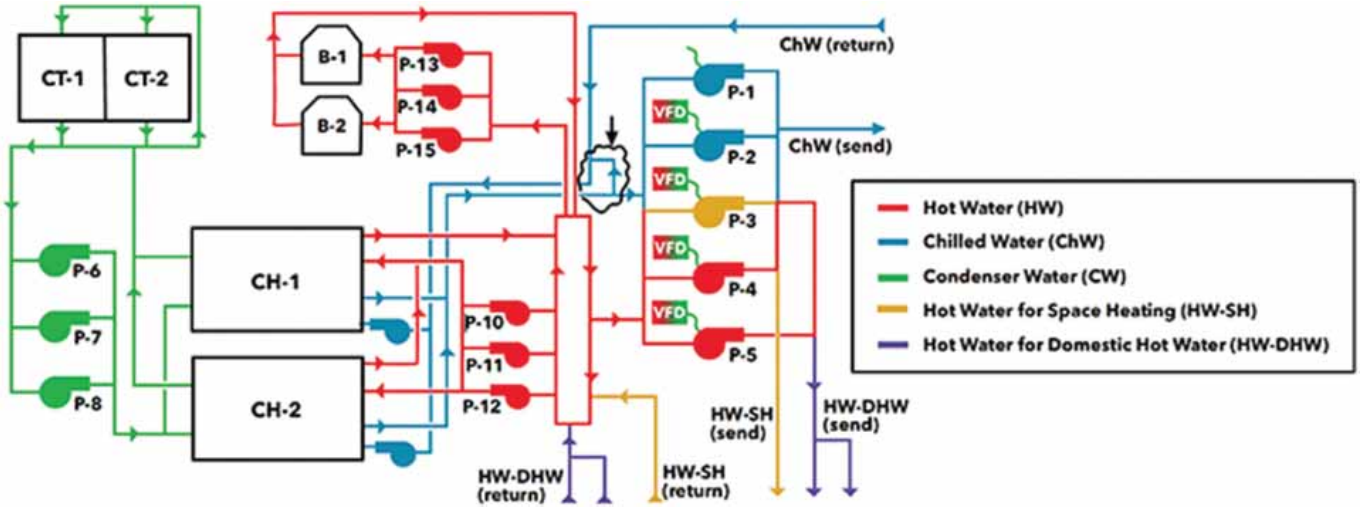


Image 3: Post-retrofit system schematic

the effects of (reduced pump size and pressure-independent control valves): Annual replacement of the chilled water (ChW) distribution pump electricity was 92 per cent lower with VFDs than without. "When comparing the combined effects of the replacement pumps and the VFDs, the ChW distribution pumping electricity reduction was 95 per cent."

Coupled with the findings in an American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE) Journal article that concluded energy improvements in the HVAC system could substantially influence 43 per cent of a building's total energy, this has a dramatic impact on the overall building energy footprint (see Image 1).

Using data collected during the initial energy assessment, Columbia University researchers and water technology company engineers jointly reviewed the data. Researchers then calculated potential energy savings and tracked key system parameters following the renovation of the chilled and hot water systems, developing a mathematical model from the data. This prescriptive pathway to assess performance offers relevant technical data that, before now, has been extrapolated solely from laboratory test results or obtained through time-consuming proprietary energy assessments.

Test Subject

Astor Place was developed by Related Companies and completed in 2005. It includes 39 residential units with commercial space on the building's first and second floors. The HVAC system uses hydronic space heating through boilers and cooling with central absorption chillers. Fan-coil units provide HVAC to residential floors; HVAC in the common and commercial spaces employs air-handling units. Only the central plant equipment and air handling equipment in the commercial and common spaces were included in the retrofit and subsequent evaluation. The approach to the ChW and hot water (HW) systems was nearly identical, though monitoring was more comprehensive on the ChW systems, the details of which are outlined here.

On the cooling side, the original 30-horsepower (hp) condenser water pumps were replaced with lower

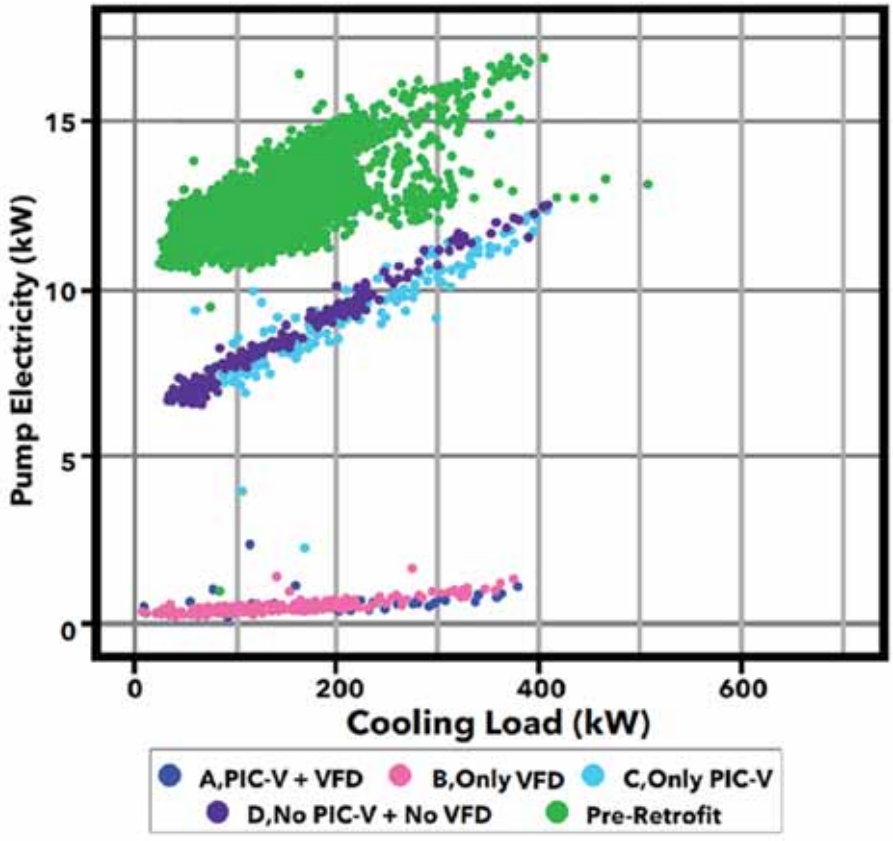


Image 4: Pump electricity versus cooling load (hourly resolution).

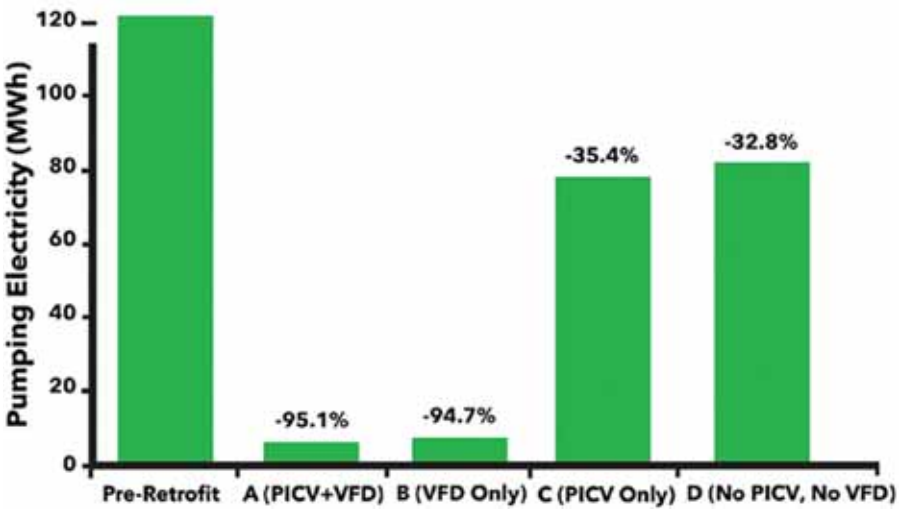


Image 5: Chilled water distribution annual pumping electricity

horsepower but more technologically advanced pumps. The new pumps immediately delivered savings in electricity use—from 25.3 kilowatts (kW) to 18.0 kW.

Other modifications included new piping to create primary or secondary chilled water loops out of the original primary only system and the addition of 7.5 hp primary pumps. Constant primary chilled water flow optimises chiller performance. Decoupling the loops in the original one-loop system allowed for the installation of variable flow technologies on the secondary loop. New 15-hp pumps replaced the original 20-hp distribution pumps and were outfitted with VFDs.

The head losses were lower than expected, so the team was able to use smaller replacement pumps. This created more energy savings potential with the VFDs than on the larger pumps. Savings from dynamic adjustment using VFDs offset additional electricity required to operate the new primary pumps.

In providing their expertise, along with the pumps, drives and monitoring equipment for the project, the water technology company engineers obtained specific real-time data on pump and system performance.

The engineers simulate real-world conditions in laboratory testing, but they do not often get the chance to follow the pumps into the field to track performance data. The intent was to improve the energy efficiency of the system without modifying the heating and cooling loads. In the lab, manufacturers can test the efficiency of a pump, but in the real world there are often unexpected variables and more complex behaviour within the system that affect efficiency.

Columbia University's Michael Waite, a post-doctoral research scientist in professor Vijay Modi's Sustainable Engineering Lab, predicated a research thesis on a new mathematical model to assess a building's energy profile that was derived from the research data. "There is a clear research gap for the evaluation of hydronic systems for large buildings," Waite said. "Their complex systems demand a different mathematical model and approach to predict energy use. You also need to get into the building to see how (it has) responded to the energy conservation measures you have made."

Energy-Savings Opportunity

Prior to the retrofit, nearly 30 per cent of the building's common system utility costs were for pumping electricity, due primarily to the pumps being oversized for the demands of the system and the constant speed operation at partial loads. Oversized pumps were found to cause unnecessarily high-pressure differentials and flow rates in the system.

Oversizing pumps is a common industry practice. There are a number of reasons why, including adding safety margins beyond those factored into the design by pump manufacturers and accounting for marginal over performance at system peak loads. However, this common practice comes at a cost—namely increases in the system's operation, maintenance and capital costs over the system's lifecycle.

When considering both heating and cooling, the retrofit resulted in a computed annual pumping electricity usage of 316-megawatt hour (MWh), a 41 per cent improvement in pumping energy requirements and an estimated 12 per cent reduction in the building's central operations' energy bills.

Commercial buildings account for 36 per cent of all US electricity consumption and cost more than USD 190 billion in

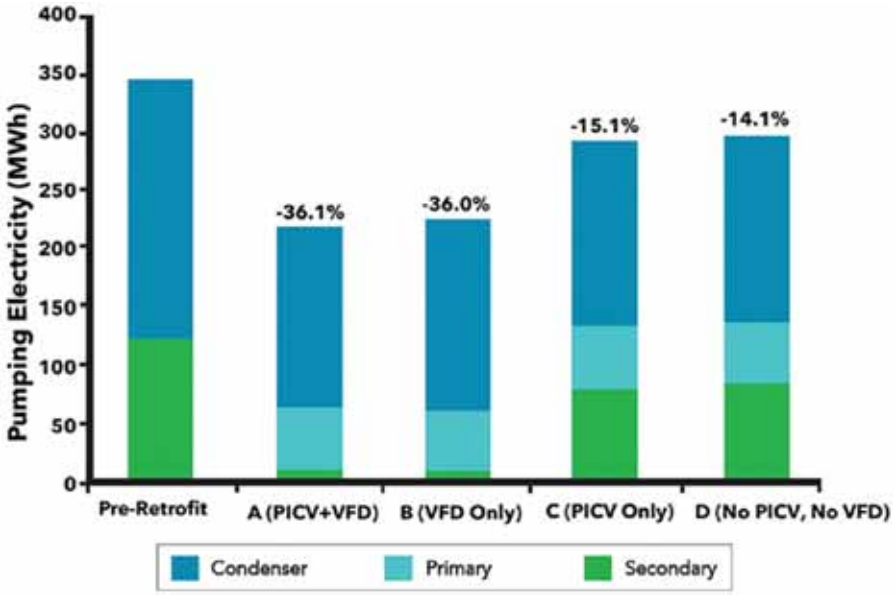


Image 6: Total annual cooling system pumping energy

energy every year, according to the US Department of Energy. With more than 80 per cent of the existing commercial and institutional buildings in the US expected to operate beyond 2030, as reported by the Colorado-based Rocky Mountain Institute, demand for HVAC system retrofits will be great.

The existing environment presents an opportunity for saving energy, creating better value for building owners and promoting sustainability.

In addition, the populous states of New York and California have in place some of the country's most stringent environmental policies—much stricter than existing federal rules—dictating that efficiency will continue to be a major consideration in selecting equipment for retrofit projects, regardless of potential federal policy changes.

VFD Story

Centrifugal pumps installed in HVAC systems typically operate in variable load applications that see a fluctuation of flow requirements based on the heating or cooling load of a building at any given time. The original pumps specified for Astor Place were running at constant speed along with being oversized for the true operational demands of the building.

VFDs were the perfect solution to address the pump oversizing. Even at peak cooling load, electricity reduction was more than 50 per cent compared to constant-speed pumps, according to the test data. VFDs do bring the most benefit in terms of energy consumption. The pumps consumed just enough energy to provide proper service for that part of the cooling loop. In addition to the VFD testing, the research team set up four retrofit combinations to collect additional data to assess the energy savings contribution of the various retrofit measures installed at the same time. The following scenarios were analysed:

- VFD and pressure independent control valves (PICVs) in operation (final post-retrofit condition)
- VFD in operation; original air handling unit (AHU) valves
- VFD bypassed; PICVs in operation
- VFD bypassed; original AHU valves (replacement pumps and primary-secondary loop modification only)

The combination of VFDs and PICVs provided the most savings in terms of electricity consumption, detailed in images 4 through 6. "A robust monitoring effort was essential to developing these fundamental understandings and the data needed to form analyses and to develop energy conservation measures," Waite said.

"This study further illustrates that replacing constant speed pumps with more appropriately sized equipment can significantly reduce their energy usage. Replacing the constant speed, constant flow primary HW and condenser water (CW) pumps provided estimated annual electricity savings of 20 per cent in primary HW pumping and 29 per cent in CW pumping," Waite said in his thesis.

Doing the Math: With all retrofits considered, the total annual cooling pumping energy reduction was computed to be 36.1 percent compared to the original system (see Image 6).

The data analysis of the pre- and post-retrofit conditions formed the basis for the mathematical model to assess energy consumption, calculating the following:

- pump power at thermal loads within monitoring range
- pump power at loads beyond monitoring range
- system hydraulic behaviour
- pump power

The mathematical model can provide a fast and accurate energy assessment of a hydronic system. From there, the team can install sensors at various points and recommend specific system improvements that can immediately reduce energy consumption and costs.

Monitoring system behaviour at Astor Place yielded three primary benefits: determine if equipment was operating as designed; assess the amount of energy being used and the dynamic adjustments to the load's demands; and gain a broader understanding of system behaviour, the last of which is most intriguing for Waite.

"This will allow us to develop theories on how systems behave as a whole rather than a collection of individual parts," Waite said.

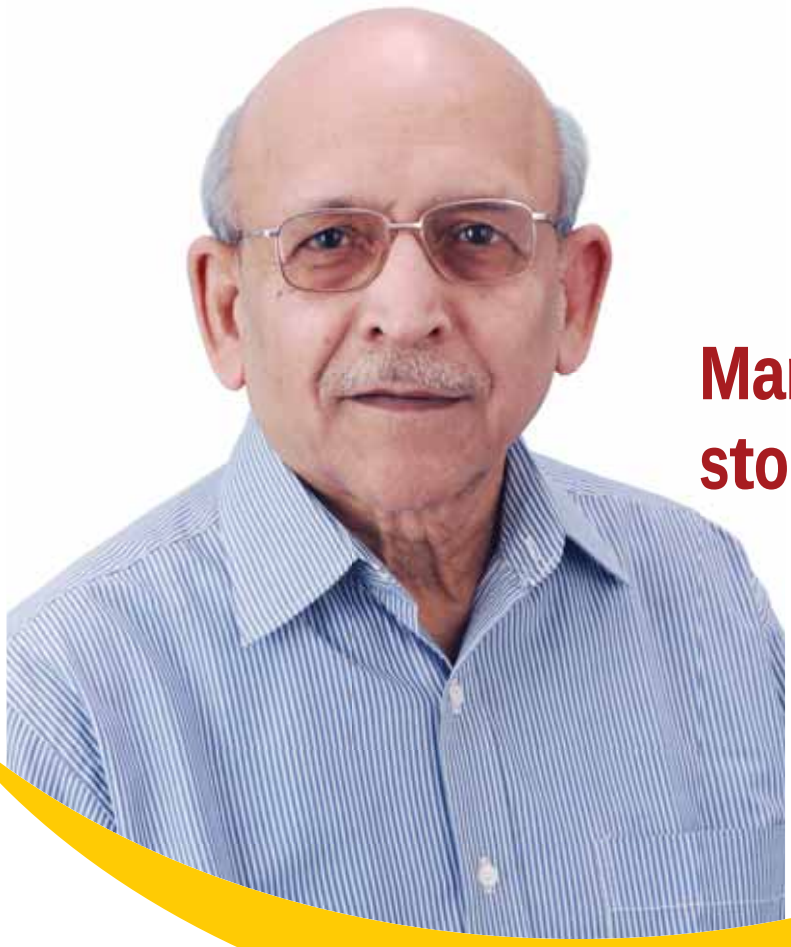
For Related Management Company, the granular focus of the project was insightful. The project gave the company the opportunity to establish a clear chain of cause and effect when dealing with energy efficiency while driving value to the condo owners through energy savings.

Future Implications

As owners seek to improve efficiency of building systems, HVAC upgrades are often last on the list due to perceived high upfront costs. The results from the Astor Place Energy Improvement Project can help inform decisions about new equipment and the potential for energy savings.

"It's not cost effective to replace a large pump as a stand-alone efficiency measure," Waite said. "But if your BMS tells you that over a decade a 25 hp pump never operated over 15 hp, you can replace it with properly sized equipment that's both cost effective and energy efficient." ■

Prof. Dr. OmPrakash G. Kulkarni
Scientist, National Space Society (NASA), USA - Certified Space Ambassador



Many more cold storages on the horizon

The Federation of Cold Storage Associations of India (FCAOI) is an all India association that exchanges and shares the latest cold storage technologies among member federations. **Mahendra Swarup, President, FCAOI** gives an insight into the Indian cold chain industry in an interview with **Cooling India**.

What are the evolutions that you have witnessed in the cold chain industry over the years?

Earlier, there was no concept of cold chain in India despite having a lot of cold storages. We have seen fish being sent to Kolkata from Punjab and Uttar Pradesh covered with ice blocks only. By the time fish used to reach Kolkata, ice used to get melt. Gradually, the concept of cold chain has taken shape and now entrepreneurs have started using refrigerated van.

Even cold storages are being constructed at the growing centres for apples, mangoes, cherry etc. There is a lot of need for cold chain in India because presently cold chain industry is at nascent stage.

Why cold chain is becoming a hot investment area in India?

There is a general perception that a lot of fruits and vegetables in India are being wasted due to lack of proper preservation and cold chain infrastructure. This generates huge potential in this sector. Hence, there is an enormous scope in the cold chain sector.

Cold chain originates right from farm or orchard level to big

cities or centres of consumption and ports or even in the ships. Thus, cold chain operation becomes complete from farm to fork. At every level, cold chain facility is needed.

What are the respective contributions of organised and unorganised players to the country's cold chain industry?

Unorganised sector constitutes a major part of the cold chain industry. Now, gradually organised sector is also participating in the cold chain industry and have started constructing air-conditioned depots at various strategic points and at ports for exports and imports.

What are the growth drivers for the industry?

Growth drivers for this industry are the development of market and the development of food processing industry that are all inter-connected. Availability of uninterrupted power is essential for the growth of cold chain industry. Cost of power along with cost of diesel is also one of the key factors that also contributes to the development of the sector.

What steps the industry is taking to overcome the challenges such as the lack of quality cold warehousing infrastructure, the low awareness of labour in handling temperature-sensitive products, the high fuel cost, power cuts, etc.?

At several strategic points, quality cold warehouses are being constructed. More sensitive equipment are being used to record temperature, humidity and carbon dioxide presence in the cold storages. So, labour is also being trained to handle such type of cold storages by various equipment manufacturing companies. To combat high fuel cost and power cuts, cold storages are trying to tread the path of renewable energy like solar power systems in parallel with grid power.

According to you, what are the key challenges faced by the industry?

There is a lack of sale of preserved food items in India. People prefer fresh fruits and vegetables to preserved fruits and vegetables. Under stressed conditions, they want to buy preserved fruits or vegetables or food items unlike western countries markets. As the market will grow, the cold chain industry will grow in the same pace.

What are the initiatives taken by the government for the industry?

The government is providing subsidy as well as technical information. National Institute of Food Technology Entrepreneurship and Management, is an example. The objective is the creation of world class institution in order to cater to the various stakeholders such as entrepreneurs, food processing industry, exporters, policymakers, government and institution. The government is also encouraging and building food parks for processing industry. This will be a big help to the cold chain industry.

Now, gradually organised sector is also participating in the cold chain industry and have started constructing air-conditioned depots at various strategic points and at ports for exports and imports.

What steps are being taken by the association for the betterment of the industry?

We are regularly educating our members in the field cold storages and cold chain asking them to put cold storages for multi-products and not just cold storages for potato only. Thus, new cold storages are coming up fast for the preservation of vegetables like green peas, carrots etc.

What are the technological developments happening for the cold storage?

New cold storages with controlled atmosphere CA or modified atmosphere are also coming up. They keep the produce in original condition. Cold storages below 0C and up to (-) 25C for the preservation of fish, meat, and fast perishable milk products, animal husbandry etc are becoming quite common.

What are the future prospects of the cold chain industry in India?

The future of cold chain industry is very bright and we hope many more cold storages would come for various food products apart from fruits and vegetables, mainly for milk and milk products, animal husbandry, fish and seafood. ■

Zero-impact supermarket cooling in Lonigo, Italy

Arneg and CAREL supply supermarket owner Maxi Di with a modulating ejector solution to develop the entire food refrigeration system.

Controls manufacturer Carel has worked with refrigerated cabinet manufacturer Arneg to provide high efficiency CO2 refrigeration for a new Famila supermarket in the northern Italian town of Lonigo.

Supermarket owner Maxi Di Srl has chosen Arneg to develop the entire food refrigeration system and to equip its new store with Arneg refrigerated cabinets.

Maxi Di's goal was to create an environmentally-sustainable system, using a zero-impact gas, while at the same time ensuring the highest efficiency on the market. Once the objective was defined and a tailor-made solution was designed for the customer, Arneg decided to involve Carel in the project, looking to innovative modulating ejector technology to help meet these ambitious goals.

Being a medium-large store (2,300 square metres), it was

decided to install an Arneg Booster transcritical compressor rack that uses CO2, carbon dioxide, as the refrigerant. Equipped with eight compressors, Carel electronics and ejectors that both fulfil in line with the latest market trends and the most recent regulations, the system supplies over 50 refrigerated cabinets – 44 medium temperature and 13 low temperature.

All the cabinets are equipped with Carel's MPX PRO, the compact and flexible controller that effectively combines ease-of-use, stable control and energy savings. Two product lines are worth highlighting: the Arneg Arles line, here supplied in the semi-

vertical version in the deli area, but also as a hot and cold showcase with "full view" glass, without metal supports, and the Arneg Velden line, the elegant semi-vertical cabinet for promotional sales.

Regarding the CO2 compressor rack, controlled by the pRack pR300T, three Carel EmJ modulating ejectors were used, for a total capacity of 185 kW. Compressor rack operation in ejector mode is an integrated solution that can reduce the cabinet superheat set point down to 0.5-degree K. In this way, the evaporators work in a semi-flooded mode with a higher pressure set point, optimising compressor rack operation and reducing the energy consumption of the entire system.

This solution brings energy savings during the summer of up to of 25 per cent, when the outdoor temperature is higher, but also in winter, via the heat recovery system that provides heating inside the building. One essential feature of the ejector solution is continuous modulation that, through dedicated control algorithms, allows the system to continuously adapt to the variations in operating conditions that are typical of refrigeration systems.

The entire system is supervised by Arneg service through its IRIS Energy control centre, optimising performance, managing unforeseen events and energy wastage also thanks to the Carel boss supervisor, which acquires system data and organises these onto a dashboard for predictive maintenance.

"For years, Arneg has been working effectively with Carel, in a partnership based on mutual exchange. Research and technological innovation have allowed us over time to offer increasingly efficient and environmentally-friendly solutions, just like the one at the Famila supermarket in Lonigo," commented Enrico Zambotto, Arneg's Refrigeration Engineering Director. "As evidence of how much we are investing in this technology, we also now adopting ejectors in other installations, always using natural refrigerants, at numerous stores in Italy." ■

Cooling Mechanism in Solar Inverter

Inverter modules generate heat and usually require a cooling mechanism. Cooling solutions are typically needed inside inverters to protect their IGBT (insulated-gate bipolar transistors) modules.

Inverters are the devices usually solid state, which change the array DC output to AC of suitable voltage, frequency, and phase to feed photovoltaically generated power into the power grid or local load. These functional blocks are sometimes referred to as power conditioning. The current can be used in two modes: (1) as an inverter changing DC to AC or (2) as a rectifier changing AC to DC, thus, charging the battery. Solar power inverters have special functions adapted for use with photovoltaic arrays, including maximum power point tracking and anti-islanding protection. Solar inverters may be classified into three types:

- **Standalone inverters:** These are used in isolated systems where the inverter draws its DC energy from batteries charged by photovoltaic arrays.
- **Grid-tie inverters:** These are designed to shut down automatically upon loss of utility supply for safety reasons.
- Battery backup inverters are designed to draw energy from a battery, manage the battery charge via an onboard charger, and export excess energy to the utility grid.

Solar micro-inverter is an inverter designed to operate with a single PV module. Its design allows parallel connection of multiple, independent units in a modular way. Micro-inverter advantages include single panel power optimisation, independent operation of each panel, plug-and-play installation, improved installation and fire safety, minimised costs with system design and stock minimisation. Few industries have introduced central solar inverters in sizes 1 MW, 1.5 MW and 2.0 MW with advanced water-cooled technology and high performance even with temperatures exceeding 50 plus degrees. This product is especially designed to suit harsh, humid and dusty conditions that prevail in the Indian subcontinent.

The standard elements are: a DC (input) module, an inverter module and an AC (output) module. The DC module includes a number of photovoltaic cells that provide a DC input to the inverter. The inverter module uses a number of electronic switches, typically, insulated gate bipolar transistors (IGBTs), to convert the DC input into an AC output.

Inverter modules generate heat and require a cooling mechanism. For low power solar inverters, providing a cooling air flow around heat-producing elements of the inverter module is sufficient. Higher power solar inverters require more sophisticated cooling. Cooling solutions are typically needed inside inverters to protect their IGBT (insulated-gate bipolar transistors) modules. These solid-state power semiconductor devices are electronic switches and consist of many devices in parallel. The design of the IGBTs and their cooling systems are among the most important aspects in protecting inverters and improving their conversion efficiency. For an example, a 1 MW inverter with 98 per cent conversion efficiency is generating about 20 kW of thermal energy. This is enough heat to warm 10 homes.

Figure 1: Different types of solar inverter

Improper IGBT design results in lower efficiency with higher heat exhaust. Cooling this heat requires a powerful cooling system. Better thermal management for the switching devices is essential to entering the next era of PV inverter efficiency, beyond 99 per cent. In the world of high rated power inverters, cooling methods need to be considered. Cooling technique includes air cooling, liquid cooling, heat pipes and refrigeration systems.

Air is a good insulator, but a relatively poor transport mechanism for removing heat. In fact, a large percentage of industrial applications move to liquid cooling, refrigeration cooling, or heat pipes at high power levels. In all of these three approaches, a liquid of some form is used to help move the heat away from a hot component. Refrigeration-based solutions are perhaps the

least used method and are only used in some specific cases. In general, these have seen minimal adoption. Similar to conventional air-conditioning systems, these approaches use a known refrigerant (often R-134a) in a two-phase cooling loop. In one part of the system, the heat causes the refrigerant to evaporate, and in another part of the system, the vapourised refrigerant condenses and is then pumped back into the system in a continuous fashion. In some cases, the internal pressure is raised very high (as much as 200 psi) and a compressor is, therefore, not needed to condense the refrigerant, but a pump is still needed for coolant circulation (Chris Thompson Eaton, 2016).

Liquid cooled solar inverters provide a cooling liquid to a liquid inlet of the solar inverter. The cooling liquid is directed around heat producing parts of the inverter and the liquid is heated, thereby, extracting heat from the inverter circuitry. A liquid outlet of the solar inverter is used to remove the heated liquid from the solar inverter. Typically, the cooling liquid provided to solar inverters is part of a larger cooling system used for many purposes. For high power solar inverters, such a mechanism is inadequate to remove the heat generated. Moreover, the integration of such a solar inverter into a cooling system on-site is a skilled task and makes the installation and maintenance of such solar inverters expensive.

Recently developed inverters

The recently-introduced PVS980 1500 VDC outdoor central inverter by ABB is optimised for large multi-megawatt solar power plants. With the simplicity of air cooling and with the power density of a liquid cooled inverter, ABB's inverter has very high total efficiency and low maintenance. There are no fill able liquids, pumps, valves, inhibitors and thus no leaks. All this makes the PVS980 suitable for any outdoor utility-scale PV plant.

GE Power Conversion is introducing Silicon Carbide (SiC) technology into its next-generation 1500V PV inverter product line, bringing increased power conversion efficiency to the PV industry. The LV5+ solar inverter is the first multi-MW, utility scale inverter based completely on SiC technology and has an efficiency rating of 99 per cent weighted EU.

Floating solar systems are gaining rapid interest across the globe and recent projects that have been in the 20MW and 40MW range are moving to the 150MW size in China, according to major PV inverter manufacturer, Sungrow in 2017. The new Samsung S-Inverter Air Conditioner series is engineered to consume less power and produce exceptional cooling comfort in 2017. The digital inverter compressor optimises usage by minimal wear-and- tear and extends the life of a refrigerator by over ten years.

Conclusion

A PV solar power system's current inverter determines the amount of AC watts that can be distributed for use, e.g. to a power grid. For systems operating in the megawatt output range, the inverters will require some level of thermal management to cool their IGBT systems. Many of these large inverter systems have custom cooling solutions that can differ from each other (e.g. air-cooling Vs liquid cooling) but all methods have their origins in cooling electronics other than those found in the solar power industry. While both low-pressure liquid cooling and high-pressure two-phase refrigeration cooling have strong performance in heat removal rate and compactness, refrigerant-based approaches have a number of documented drawbacks when used in power conversion. Due to these drawbacks, this technology has seen negligible adoption in established power conversion markets such as UPS, motor drives, or wind and solar inverters. In particular, component availability, maintenance, and toxicity pose significant challenges. Multiple EPA proposals could also have a dramatic impact on the usability of R-134a in the future. When selecting power conversion equipment for high power applications, consider not only the cooling performance of the approach but the ability to safely own, maintain, and operate the system for years to come. Some the key players in the water-cooled inverter market include Hitachi, Daikin Industries, Fuji Electric Corporation of America, Mitsubishi Electric Corporation, Olympia Splendid SpA, Dunnair International, KITA Mfg Co, and Blue Box Group S.r.l, Regen Powertech and GE Energy Power Conversion UK Ltd are a few others that make use of these inverters solely as solar inverters.■

Er. Kapil Kumar Samar
Project Manager, Biogas Development and Training Centre, Udaipur.

Cold Box

Innovative Cold Transportation Solution

Cold Box operates on battery power that is clean power and does not pollute the air unlike the conventional reefer trucks that guzzle diesel and emit substantial pollution.

Figure 1: Cold Box – Active Refrigeration For LTL Ground Transport

Stack Boxing – for Multi Temperature Transportation

The Indian Cold Chain scenario does not, very often, find introduction of innovative products and solutions that catch the eye of the user fraternity. However, recently we saw one such innovative cold transportation solution. Let us take a look at this solution, its features, advantages and who would be the prime users of this product.

The product is wisely called The Cold Box. It is an insulated box approximately the size of 7' X 5' X 7' having a storage capacity of about 60 cubic feet. (Refer Fig 1) The Box is equipped with an on board active refrigeration system (operating on Freon) that can be adjusted for delivering a wide range of temperature setting between Plus 50C and minus 20C.

Table 1: Specifications of the Cold Box

Length	7 Ft (External)
Width	5 Ft (External)
Height	7 Ft (External)
Tare Weight	635 Kgs
Payload	800 Kgs (depending on Weight : Volume Ratio)
Refrigeration	Freon based- Battery operated
Automation	Cloud Based Control
Tracking	Cloud based Real Time Tracking
Temperature Settings	+50 Deg. C to -20 Deg. C
Compliance	Meets FDA 21 CFR Part 211 for Pharma products Meets GMP requirements for Food & Pharma
Temperature Accuracy	Within - / + 1 Deg. C

The Cold Box has a tare weight of approximately 635 kg and it can take a payload of about 800 kg. The Cold Box can be loaded onto any type of flat bed truck with appropriate dimensions to hoist the box onto it. The most innovative and key feature of this box is that it does not require any prime mover like vehicle driven power to operate its refrigeration system. The refrigeration system is driven by a set of high-performance batteries that can operate the refrigeration unit for over 3-4 days on a single full charge. The Cold Box is easily lifted onto the flatbed truck or van by means of a fork lift. It can be charged even as it is on the stationery vehicle. All it requires is a 15 Amp plug point to charge. The Cold Box is designed to meet the FDA specifications and has, several innovations like cloud-based tracking and tracing. All

Table 2: Advantages of The Cold Box

Stack Boxing (Refer Fig 3)	A large Flat bed truck can accommodate 3-4 Cold Boxes with different temperature settings to transport different products at different temperatures.
No Pollution	Operates on Charges High Performance Batteries
Mean Time of Travel between Battery Charges	On One Full Charge of batteries ,the Cold Box can travel up-to 5 days at a setting of 0 Deg. C.& ambient of 40 Deg. C.
Versatile Transport	The Cold Box can be loaded onto any Flat bed truck of appropriate dimensions.
Vs Reefer Truck	The Cold Box can transport small quantities of payload at highly economic values. **Field case studies have shown 39 to 58% Savings over Reefer Trucks.**
Vs Reefer Truck	The Cold Box **does not need** vehicle power to run its On Board Refrigeration system.
Vs Reefer Truck	The Cold Box is FDA & GMP compliant transport solution.
Vs Passive PCM	The Cold Box has an On Board Refrigeration that can operate for 5 operating days / travel time and thereafter needs a re charge en route to continue another 5 days. Recharge of batteries using any 15 Amp Electrical supply socket.

Table 3: Applications of The Cold Box

Pharmaceuticals
High Value Specialty Chemicals
Bio Technology
Genomics
Coatings & Adhesives
Electronics
Medical Devices.
Oil Services
Ready To Eat Foods
Catering Services / Event Management
Craft beers / Breweries
Intra City Dairy products Delivery
High Value foods like Specialty Cheese / Yogurt

specifications are exhibited in Table 1. This makes the Cold Box a very versatile solution to transport a wide range of perishables.

There are several advantages of the Cold Box over the conventional reefer trucks that ply the Indian roads today. One of the biggest advantages is that the Cold Box operates on battery power that is clean power and does not pollute the air unlike the conventional reefer trucks that guzzle diesel and emit substantial pollution. Other advantages like multi-temperature stack-boxing and others are listed in Table 2.

The product was initially developed in the USA for transporting Small Volume High Value (SVHV) pharmaceutical products between the Pharma Cold stores and the airports. This specific duty is called as 'Airport Ingress & Egress.'

In India as well as globally the user fraternity is in search of a Less Than Truck Load (LTL) Cold Transportation solution that can effectively and economically transport small volumes of high value products under active temperature control. The Cold Box has been by far the best solution to come along beating all its alternatives (like PCM based solutions) on account of its active on-board refrigeration. As its popularity and versatility was understood by the transporters and asset owners, its use for cold transportation spread to other sensitive products like chemicals, high value food additives and food products (Table 3).

SUMMARY

SENSOR SUMMARY

	[°C]	[°C]	[°C]	[Pa]	[Pa]	[%]	[%]
Start Values	7.0	36.4	7.3	-	-	93.3	-
Mean Kinetic Temperature (MKT)	+7.0	+28.9	+7.1	-	-	-	-
Max Values	7.5	43.9	9.3	-	-	100.0	-
Min Values	6.5	18.1	2.9	-	-	43.1	-
High Extreme Count	-	-	-	-	-	-	-
- Excursion Time	-	-	-	-	-	-	-
Low Extreme Count	-	-	-	-	-	-	-
- Excursion Time	-	-	-	-	-	-	-
End Values	7.5	27.1	7.7	-	-	62.5	-

TRANSPORT SUMMARY

Time	**Start:** 3/15/2019 1:24 PM IST **End:** 3/22/2019 7:43 PM IST
Time Zone:	IST - Asia/Calcutta
Start Address:	Illalur, County Kanchipuram, Tamil Nadu, Route Unnamed Road, IN
End Address:	County Gurgaon, Haryana, Route Unnamed Road, IN
Run time	7 d 6 h 19 min
Log Count	4190
Lost GPS count	668

Figure 3a: Performance in Summer of 2019- 7 days' journey Tamil Nadu to Rajasthan

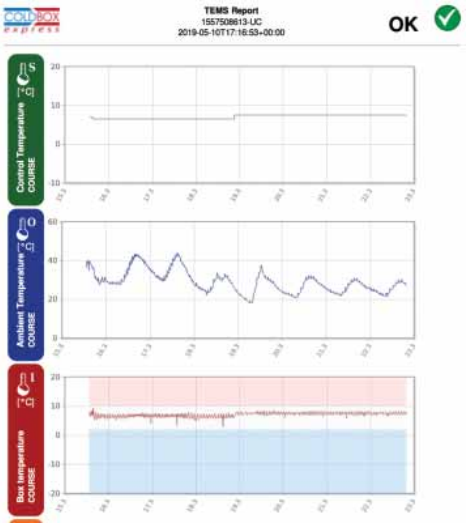


Figure 3b: Performance in Summer of 2019 - 7 days' journey Tamil Nadu to Rajasthan

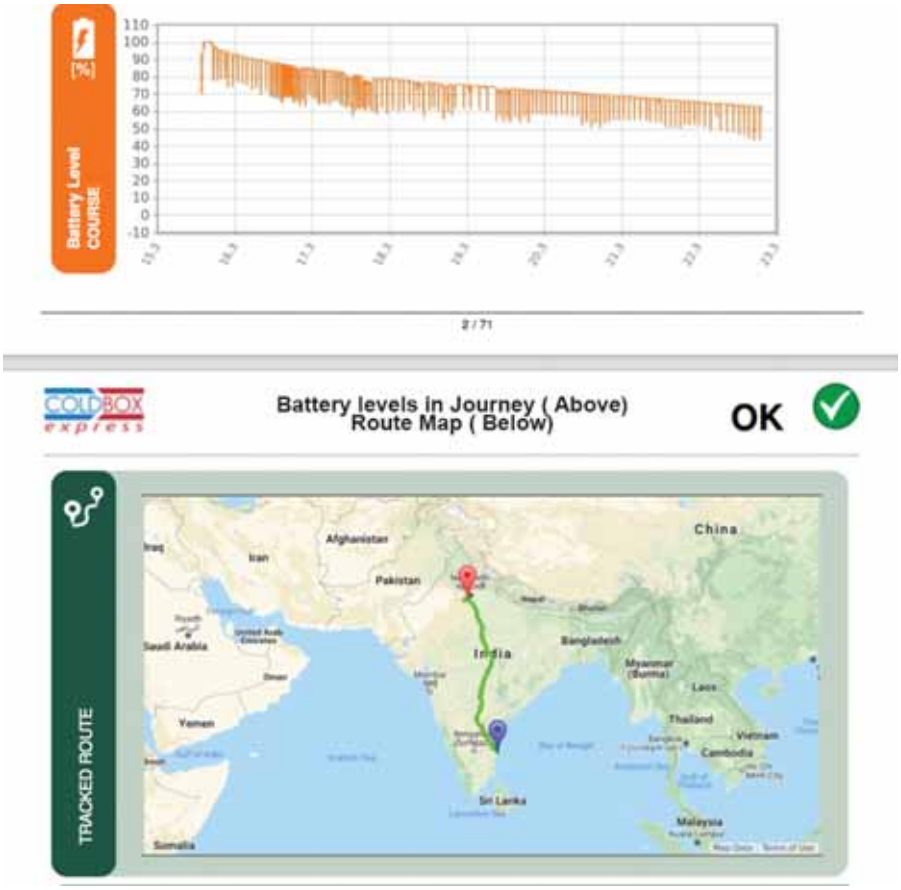


Figure 3c: Performance in Summer of 2019- 7 days' journey. Tamil Nadu to Rajasthan

Today, the Cold Box is poised for a major role in the LTL Cold Transportation in India. Trials in this summer have proven extremely effective. A tracker of one such trial with live load for a very reputed chemical company is exhibited alongside (Refer fig 3-A-B-C). The trials were conducted from Tamil Nadu in south India to Rajasthan in North West India.

Indian industry and businesses badly need this solution to optimise the costs of LTL Cold Transportation throughout the country as it moves ahead in thrust areas like food distribution, food wastage savings, safe pharmaceutical product transportation, Vaccine distribution and healthcare for its population living in far rural outreach of the country. ■

Manjunath M S
Advisor
Cold Chain & Innovation
The Cold Box Express Inc.

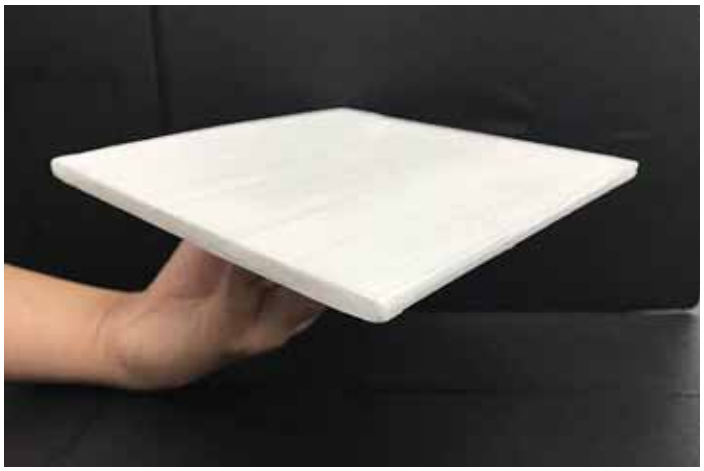
'Cool wood' can help to keep buildings cool

University research groups claim to have developed a new wood-based building material which is able to passively take heat out of homes or offices. Researchers at the University of Maryland and University of Colorado Boulder have created the new material by removing lignin, the key organic polymer that gives wood its strength and colour. The resulting pale wood made of cellulose nanofibers was then compressed to restore its strength and a super hydrophobic compound added for protection and to make it water repellent.

But it also absorbs infrared light, which means the wood warms up in the sun. The researchers heated and compressed the remaining cellulose, creating an engineered wood that's eight times stronger than the natural variety.

The engineered wood is not just strong. The pale-coloured cellulose reflects almost all incoming visible light and absorbs very little infrared light, reflecting it away. It is also able to absorb heat from its surroundings, and radiate it back out. It can cool down surfaces it's attached to by up to 10C and could reduce energy costs by 20 per cent to 60 per cent according to a paper in Science.

Air conditioning is a significant, and rapidly growing, contributor to global warming. It creates a vicious circle, pumping out heat from buildings, which then increases the need to use AC.



Buildings made from this engineered wood should let us rely on it a little bit less.

It is a useful contribution to the field of heat-reducing materials, but it would be much more expensive than standard wood, which is rarely used for roofing. Much of the growth in dwellings around the world is in the form of urban apartment blocks, which are often made of cheap concrete. This sort of wood could potentially be used as external cladding, but it's flammable and less durable than other materials. ■

Lamilux Committed to development of Indian cold chain

Lamilux is a provider of light-weight glassfiber-reinforced plastic (GRP) solutions for a wide range of applications. In the Indian market, the German firm has been offering solutions for sandwich panel construction of truck bodies since 2009. **Rohan Bellikatti, Regional Technical Sales Manager – South India and Sri Lanka, Lamilux** comments on Indian cold chain scenario, challenges, and the solutions offered by the company in an interaction with **Cooling India**.

According to you, why is India's cold chain sector still at nascent stage?

USD 13-14 billion is the value of annual wastage in India's agricultural sector due to inadequate cold chain infrastructure. 18 per cent of fruits and vegetables produced in India get wasted due to insufficient cold chain network, and this is a direct contributor to food shortages which in turn results in higher prices. While the ambient supply chain has evolved in last one decade, the cold chain network in India remains at a very nascent stage with only 10-15 per cent of network being served by organised players.

What kind of active role does Lamilux envisage for itself for the development of Indian cold chain sector?

Lamilux India has been offering solutions for customers in the Indian market for sandwich panel construction for truck bodies and many other applications since 2009. Having played an integral role in helping develop the country's cold chain in close association with the National Centre for Cold Chain Development (NCCD), Lamilux remains committed to the Indian market with renewed thrust on market expansion and deeper penetration. Yes, indeed this has to be approached by both government sector and private sector on war

> Lamilux GRP can be used in reefer containers, dry freight containers, cold rooms, etc and also GRP can be used in existing cold rooms to avoid corrosion and enhance the efficiency in cold rooms.

footing to reduce the wastage of food and we at Lamilux assure that we are dedicated to walk the extra mile in the development of Indian cold chain industry and better infrastructure by providing technical solutions.

What kind of challenges do you face in cold chain transport in India?

'Change' the word itself is one of the biggest challenges in India. It is like 'Who is going to bell the cat and people don't wish to do what it requires. They are contented with the conventional methods which itself is one of the biggest hurdles for us. India is growing, population is increasing at a rapid pace and yet we don't have the infrastructure to store and preserve food. We also need the government to step in with some schemes for the cold room owners, investors, reefer fleet owners and encourage them to invest, expand their business reach and have end-to-end solutions so that food is not wasted. Further, it is also necessary to make sure that right products are used for reefer trucks, cold room and warehouses so that the quality and efficiency output are not compromised.

What solutions you would like to offer to overcome these hurdles?

Lamilux has a basket of products for reefer truck manufacturers and cold rooms. GRP is one of the ideal solutions with advantages and benefits more than the conventional products like steel and aluminum. In today's world, everyone wants light weight solutions and price competitive products to sustain and survive in this industry. We provide the same. Lamilux GRP can be used in reefer containers, dry freight containers, cold rooms, etc and also GRP can be used in existing cold rooms to avoid corrosion and enhance the efficiency in cold rooms.

What are your top new and innovative solutions or technologies particularly related to cold chain sector?

We have a lot of products like High Gloss, Gewebe, Gewebe 48 per cent SH, Embossed, Lamigraph, Lamifoam tex, Super, Super Plus, Anti-bac, Anti-slip, Composite floor and the latest launch is the Texture wall with various thickness and glass content. Lamilux believes in innovation and as a team, we are all focused in developing new products which can be a solution for the challenges being faced currently in various industries and segments.

What are unique features and applications of Lamilux GRP?

Every product has its own unique features, advantages and benefits. Applications for these GRP can be used in reefer containers both interior and exterior surfaces, dry freight containers, cold room panels, construction industry in buildings, wall cladding, partition walls, shelter homes, caravans, bus roofing, floorings, etc.

Savings on fuel, wear and tear of tyres, higher payload carrying capacity, faster application, aesthetically good looking, durable, chemical resistance, etc are few of the features of Lamilux GRP. More detailed features and benefits are explained on our website www.lamilux.com.

What kind of potential do you envisage for these products?

These products (GRP) have a huge potential considering India's cold chain industry and the technical advantages that they possess against the conventional methods and products used. As we know that India is a developing economy and globally, it is assumed that the country has conducive environment to attract foreign investments.

Tell us how has 2019 been for Lamilux India so far?

In terms of business growth, I can only say right now that we are on the track. It's just half the year now and still we have to go long way so we can't comment anything. We have a very strong and dedicated team who believe in themselves and serving the customer first which is our top priority. We also believe to walk the extra mile as stated earlier only for our clients. ■

Energy Efficiency & Star Rating Systems in Buildings

The article lists the various certification systems focused on energy efficiency and their penetration in the Indian market.

As the famous management saying goes, what cannot be measured cannot be managed. This is very true even in the management of energy and the associated costs that go with the energy usage in a building. As everybody knows, more than 40 per cent of the energy goes into running of the HVAC systems in a building. Thus, it makes business sense for the building owner or occupier to manage these costs as much as possible to keep the overall operating costs low. In addition, there are many other energy consumers in a building such as lighting, elevator loads etc. that also contribute to the overall building load.

While there are several ways to assess efficiency of a component or system in a building such as the IKW approach for chiller efficiency, the overall building efficiency is a more relevant measurement to undertake as it allows the owners to get an overview of the building's performance and corrective measures can be taken in an integrated manner. Thus, several building rating systems have come up over the last 2 – 3 decades in the western markets and in about 8 – 10 years in the Indian scenario. This article lists the various certification systems focused on energy efficiency and their penetration in the Indian market.

Building rating systems overview: Internationally, there are many building rating systems in vogue and mostly each of the developed markets having their own rating systems for building efficiency. The US uses the LEED (Leadership in Energy Efficiency Design) rating system developed by the US Green Building council (USGBC), The BREEM (Building Research Establishment Environmental Assessment Method) rating is widely used in UK or Europe and in Australia, the NABERS (National Australian Built Environment Rating System) is used. In India, there are several energy and building rating systems in use which have been developed by Indian rating agencies or have been modified by the international agencies for use in Indian conditions. Figure 1 shows the various ratings systems commonly in use in India.

There are two types of rating systems – one approach is to rate the overall design and performance of the building, covering various aspects such as energy, air quality, transportation, sustainability etc. The other is a more energy usage focused approach which assesses the building's energy use. Both approaches have their advantages and disadvantages and hence should be adopted after careful consideration of what is the end objective of the owner who is taking the path to certification.

Whole Building Rating Systems

These rating systems are the most common in the current Indian building environment. Most of these rating systems have both design-based ratings as well as ratings that measure a building once it is operational. The whole building rating approach covers various aspects of the building including design elements that impact energy use, sustainability aspects, human comfort etc. The various rating systems in use in in India are as below:

- **IGBC Green Ratings:** This is one of the most common rating systems in the Indian market as it has been designed for the local conditions. Set up as a joint initiative of CII and Godrej in 2001, the Indian Green Building Council (IGBC) has evolved into a powerhouse of the green movement in India and there are now many ratings that the council offers. The IGBC Green Existing Building O&M rating is used by building owners to assess how their asset is performing on energy, water, facility management, health and innovation and the ratings are given as 'certified', 'Silver', 'Gold', and 'Platinum'. The assessment is based on operational data for the last one year and the pre-requisite for certification is 80 per cent occupancy and more

than 1 year of operations. The certification is valid for 3 years.

- **LEED Certifications:** The US based USGBC introduced LEED in India in the mid-nineties and set the agenda for the building performance measurement. Over the period, the LEED standard has been customised for the Indian standards and is still considered as a valuable certification to be achieved for Grade A building owners and occupiers. The existing building standard focuses on the performance of the building post commissioning and rates the building on sustainability, energy efficiency, water efficiency, air quality, materials and innovation.
- **GRIHA:** This standard was developed by TERI (The Energy Research Institute) in 2007 and is India's national rating system adopted by the government (Ministry of New and Renewable Energy) as well. The rating system has been developed for the Indian environment and is a much simpler rating tool than the other standards. A GRIHA rating system uses a 'Star' rating approach, with building rated from 1-Star to 5-Star. The existing GRIHA rating system assesses the building on site parameters (Impact of building on the surrounding), maintenance, energy, water, human comfort and social aspects (accessibility etc.). Since this is a national standard adopted by the government, there are various incentives that are given to buildings that get certified. Many state governments give additional FAR for achieving this standard and many banks also give loans at concessional rates for GRIHA certified projects.
- **GEM:** This is a new standard that has been developed by ASSOCHAM (in 2017. The GEM (Green & Eco friendly) standard is relatively new in the market and follows a more detailed approach with 27 measurement areas.

Energy Efficiency Based Ratings

While the whole building, integrated approach covers many building O&M aspects, the focus is distributed. In the developed markets, building energy usage specific ratings are used to monitor the performance of this key component of building operations as well as cost baseline. The Energy Star program in the US run by the EPA (Environment Protection Agency) rates buildings of various classes and size based on national scientifically developed benchmarks. The Indian standard that uses energy use as the base is the BEE Star rating standard.

Figure 1: Building Rating Systems

- **BEE Star Rating for Office Buildings:** This standard was developed in 2009 by the Bureau of Energy Efficiency (BEE). The standard assesses the actual energy performance of the building based on the energy bills for the last three years and the buildings are categoried as per the 4 climatic zones that India has been divided. The rating is on a 1 to 5 star basis, with 5 stars being the highest and representing the most energy efficient building operations. The performance is calculated by arriving at the EPI (Energy Performance Index) which is the amount of energy consumed per sqm per year in the building. This rating system allowis building owners to know how their building is performing on the energy usage front.

Which System to Use?

With many energy performance rating systems available to the asset owners, there is always a dilemma on which is the best option. While there is never an easy answer to this question, the building owners could ask themselves what the reason is for their taking the certification and then work out the best option. Certifications cost money and that can be a deciding factor as well. Having an existing building certification can help the owner get higher rentals as well as lower operating costs for the tenants. In addition, the rating shows to the community that the asset owner is a concerned citizen. If improving energy efficiency is the key driver, especially for older buildings, then an EPI based approach will be beneficial. Thus, a building owner will have to assess the key reasons for going in for the certification.

Conclusion

Benchmarking one's asset or building is the first step to understand how the building is performing and this can form the basis for improving the building performance. Energy being a major cost contributor to a buildings operating budget, it is imperative that the energy us used effectively. In addition to the cost, there is the impact to the environment that one should keep in mind, and thus, going for a building certification will help minimize the impact on the surroundings as well as the overall climate. There is thus a strong case for building owners to take energy efficiency certifications for their buildings. ■

Aneesh Kadyan
Sr Director - Operations,
CBRE

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HVAC System Design for Multi-Specialty Hospital

The article sheds light on various aspects that need to be taken care of while designing HVAC system for a healthcare facility.

Photo Credit: www.gagneac.com

Hospital air conditioning is always considered as high sensitive issue while planning with other services. Recently completed healthcare project by the author is a multi-specialty hospital located in new Mumbai, where two aspects were very important. One is the high end HVAC system required for healthcare and second is the height restriction in between false ceiling and slab to run all services. Another challenge came while crossing the ducts and pipes within the beams. Care has been taken to provide all modern facilities available either in Apollo or Seven Hills or so on in this type of hospitals where construction area is nearly 50,000 square feet.

Various aspects need to be discussed in planning stage itself which will help in smooth execution.

- The need to restrict air movement within and between various rooms especially when operations carried out. Air lock of as small as 20 square feet has provided with positive pressure difference from adjacent rooms. This pressure difference achieved though control of fresh air in all adjacent rooms.
- The specific requirements for ventilation and filtration to dilute and remove contaminants in the form of airborne microorganisms, viruses, and odour. Separate fans with individual ducting have provided in these rooms so that there is no mix of air take place.
- Different types of temperature and humidity requirements for various areas. It was not possible with only VRV system, when specialised dehumidifiers installed in different rooms to control the humidity.

- Permit accurate control of environmental conditions through centralised VRV system.
- Control of air quality and air movement through air handling units, fan coil units and Treated Fresh Air units.
- Provide a healthy and lavish atmosphere to take care of high end client, especially when they are waiting for their turn to come.

While designing the different rooms of the hospitals, the design team has gone through various alterations of design to achieve the goal while not compromising the technical responsibility as a consultant.

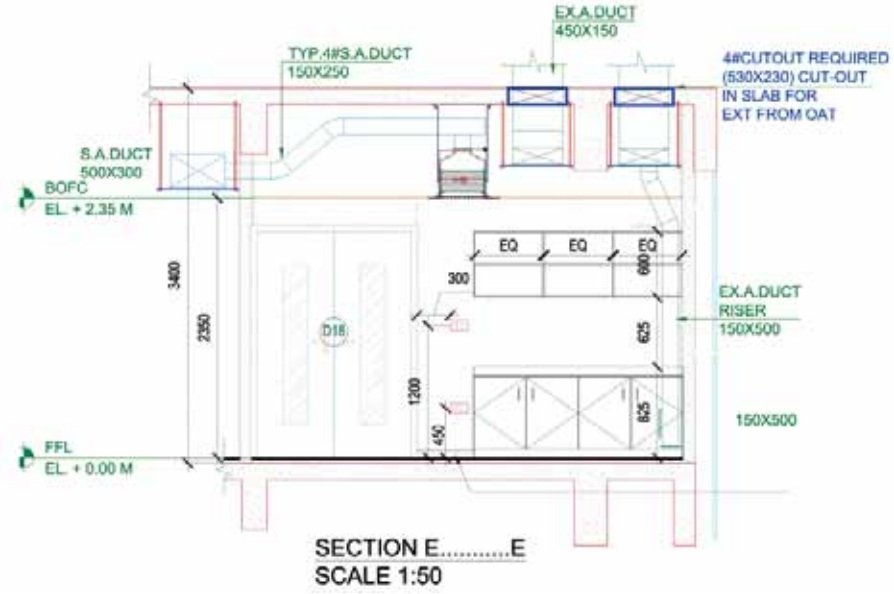

Figure 1: Operation Room Ducting Layout

Control of infection sources and its measures in Operation Rooms

Infectious bacteria are transported by air. Droplet or infectious agents of 5 mm or less in size can remain airborne indefinitely. It has been shown that 90 to 95 per cent effective filters remove 99.9 per cent of all bacteria present in hospitals. Epidemiological evidence and other studies indicate that many of the airborne viruses that transmit infections are sub-micron in size, thus, there is no known method to effectively eliminate 100 per cent of the viable particles. HEPA filters or Ultra-Low Penetration (ULPA) filters provide the greatest efficiency currently available. Considering this, the isolation rooms with appropriate ventilation pressure relationships have provided to prevent the spread of airborne viruses in the hospital environment.

Use of Treated Fresh Air system in entire premises

Treated Fresh Air (TFA) has a major role to play in hospitals. Outdoor air in

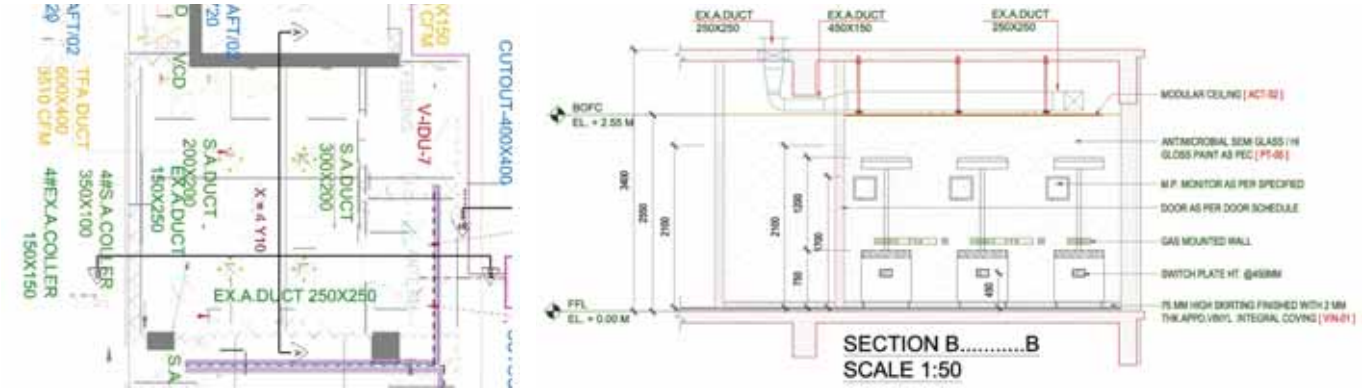

Figure 2: NICU rooms with Section

comparison to room air is virtually free of bacteria and viruses. Infection control problems frequently involve a bacterial or viral source within the hospital. Ventilation air dilutes the viral and bacterial contamination within the hospital. Properly designed, constructed and maintained ventilation systems preserve the correct pressure relationship between functional areas; they remove airborne infectious agents from hospital environment. Fresh air at a rate of 15 CFM per person have provided in all rooms and care has been taken that same amount of air get extracted through toilets fans all times so that there is a continuous air change in the premises.

Isolation Rooms(NICU)

There is one NICU room which has to be separated from other rooms. With the patients of harbour transmittable microorganisms helps in various modes of transmission to contaminate the environment creating the necessity to control infections. For this, there is a need to create the following special isolation rooms:

- Standard Pressure Room for patients who require contact or droplet isolation is provided.
- Negative Pressure Room for patients who require airborne droplet nuclei isolation to reduce transmission of disease via the airborne route (Class-N) is provided.
- Requirement of separate exhaust system dedicated to NICU room, removing a quantity of air greater than that of the supply system have provided.
- Directs the exhaust directly to outside also provided with by pass connection.
- Positive Pressure Room with a positive pressure relative to the ambient pressure to isolate immuno compromised patients such as certain transplant and oncology patients have provided. The aim is to reduce the risk of airborne transmission of infection to susceptible patients (Class-P).

Isolation Room Pressures

Room Type	Room	En-suite	Airlock
Class N	- 30 pa	- 15 pa	-15 pa
Class P	+ 30 pa	+15 pa	+15 pa

Importance of Air Lock Function

1. Provides a barrier against loss of pressurisation and against entry or exit of contaminated air in or out of the isolation room when the door to the air lock is opened.
2. Provides a controlled environment in which protective garments can be donned without contamination before entry into the isolation room.
3. Provides a controlled environment in which equipment and supplies can be transferred from isolation room without contaminating the surrounding areas.

Humidity Control

Bacteriological microorganisms ride on dust particles. Its attract ability to one another is favoured by low relative humidity resulting in increased static energy. High humidity in the hospital enhances the danger of growth of Pseudomonas aeruginosa. Humidity in operation room is believed to contribute to the prevention of dehydration of exposed tissue. At relative humidity of about 50 per cent, a very thin invisible film of moisture forms on the operation equipment and other surfaces. This film of moisture conducts static electricity to earth before a spark producing potential is built up. To minimise the explosion risk, the relative humidity required is 40-65 per cent. VRV Indoor Units have installed with RH indication in the remote controls have provided along with few portable time dehumidifiers.

Conclusion

The entire design team has tried to take care of all minute aspects with support from doctors' team to provide maximum facilities in minimum space available. ■

Firoj Jena
Chief Executive Officer
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Cold Chain Under Control with Testo

The most elementary and necessary part of human being's daily routine is the food. Health and wellbeing of human kind depends on every edible item that the human being consumes. Be it vegetables, meat, fruits, beverages or any other stuff, quality and fitness of these consumables have far reaching consequences on human being's life. Thus, storage of food items is of the highest priority. On the way from the raw material to the sales-ready goods, food pass through different processing levels and processes. This results in a chain of producers, processors and dealers. No food may ever be brought into circulation that is damaging to health or unsuitable for consumption.

Importance of Cold Chain

When customers buy food, they expect that the products are of impeccable quality, and safe. In order that this really is the case, the cold chain is crucial for refrigeration-mandatory foods such as meat and sausage or dairy products. It ensures the quality and safety of foods. Legally prescribed temperature limit values may not be exceeded on the way from the producer to the consumer. As the safety and quality of food can be negatively influenced by the wrong temperature, the monitoring of temperature of cold chain-mandatory product is a central building block in the assurance of the desired quality and marketability.

Precise measurement process for superior quality

In the monitoring of temperatures, two types of techniques are used:

- Spot check measurement with portable temperature measuring instruments. These can be with permanently fixed probes or with exchangeable probes, mostly when varying measurement tasks are required. This can also be conducted by using non-contact measurements using infrared thermometer.
- Continuous data recording in which a measuring instrument with a memory remains with the goods (or in their proximity, e.g. in a refrigerated room), and records values at regular measurement intervals. Data loggers are used for continuous data monitoring.

Measuring instrument with fixed probe

A very precise measurement is a core temperature measurement, i.e. a penetration probe measures the temperature in the interior of the refrigerated goods. However, for many products, this means destroying the packaging and the product. To avoid this, a 3-level process has proven its worth in practice:

1. First, an infrared measuring instrument is used to scan the surface, e.g. of yoghurt pots. Infrared measuring instruments are suitable for obtaining a rapid overview of the temperature of the products. If the temperature is clearly within an acceptable range, the test is finished.
2. If the temperature of some products is outside the prescribed range, then a contact probe is inserted between two products, and the temperature is measured there. If the temperature is now within the limit values, then the previous infrared measurement showed merely a warming of the outside.
3. If the temperature is still outside the prescribed range, then for verification purposes, a penetration measurement is carried out on one or more pots. The probe is inserted into the foodstuff, and measures the core temperature.

Measurement necessary at every step

Product processing and storage

Fresh and frozen goods whose preservation and quality are dependent on permanent refrigeration require an uninterrupted cold chain to protect them from spoiling for as long as possible. For refrigeration-mandatory foods, legal stipulations regulate the temperature zones which must be adhered to during the cold chain.

- Deep-frozen meat and fish need to be continuously chilled through to (-)18C.
- Maximum temperature required for fresh meat is (+)4C, for milk and dairy products is (+)8C.
- For fruits and vegetables, a temperature range of (+)1 to

Measuring transport conditions with testo 184

(+)12C is applicable.

Food transport

Here, the focus is on the transfer of liability. For the purposes of traceability, the freight forwarder must be able to prove that the cold chain was not interrupted during transport.

Measurements carried out during transportation call for special data logger requirements:

- Limited package space necessitates a flat design
- Easy to use
- The logger should only record transport-relevant data
- Alarms must be easy to recognise, to initiate control measures in time.

Recommended instrument

Transport data logger testo 184

Incoming Goods

Incoming goods is the location at which foods are delivered. In the context of food safety, fresh food and frozen goods deserve special attention here, because adherence to the cold chain is prescribed for them. Different temperature ranges apply for each of these product groups:

- Deep-frozen foods: (-)18C


Checking temperature in Incoming Goods with testo 831

- Minced meat: (+)2C
- Fresh fish (in ice): (+)2C
- Fresh poultry: (+)4C
- Processed fish (marinated, soured and smoked): (+)7C
- Other perishable foods, including e.g. baked goods with incompletely baked filling or covering, freshly cut salads and delicatessen salads: (+)7C
- Pasteurised milk: (+)8C
- Butter, cream cheese, soft cheese: (+)10C.

The handover of goods generally takes place in the loading bay. Immediately after the supplier's arrival, the temperature is measured here either on the loading platform or directly in the truck.

Recommended instrument: Non-contact infrared thermometer testo 831 and data loggers.

Refrigerated counters, shelves etc.

In sales outlets, products in need of cooling are stored either in refrigerated units (shelving, displays, counters) or in deep-freezers.

Refrigerated products: The temperature of sealed products is usually measured without contact. For meat, sausage and cheese, a penetration measurement is normally carried out. The permitted temperature range here is typically between (+)2C and (+)10C.

Deep-frozen products: Non-contact measurement or measurement between packages. The permitted temperature range here is typically between (-)20C and (-)18C.

Refrigerated shelving, counters: Data loggers are installed in refrigerated shelves or counters close to the air intake, as the air temperature is warmest here (should still be under (+)10C). In deep-freeze units, a measurement is taken ideally between the packaging (e.g. spinach, pizza, ice cream).

Refrigeration and deep-freeze rooms are usually monitored using the "semi-stationary" method, i.e. a data logger is fixed to a wall of the refrigerated room, where it measures and records the air temperature.

Recommended instrument: Non-contact infrared thermometer testo 831 & data loggers.

Safe food safer human being

Refrigeration prolongs the lifetime of foods and hinders germ growth. The adherence to the cold chain serves the quality and safety of foods. There are various ordinances, norms and standards about the cold chain. They stipulate, among other things, that proof of temperature compliance is a mandatory requirement. HACCP describes the implementation of process-oriented hazard analyses. Where risks occur, control points must be set-up and correction measures must be taken. Testo India provides the best solutions and precise instruments that comply to several necessary norms and ensure the safety of the society. ■

Global chiller market to grow at CAGR of 4.9% by 2024

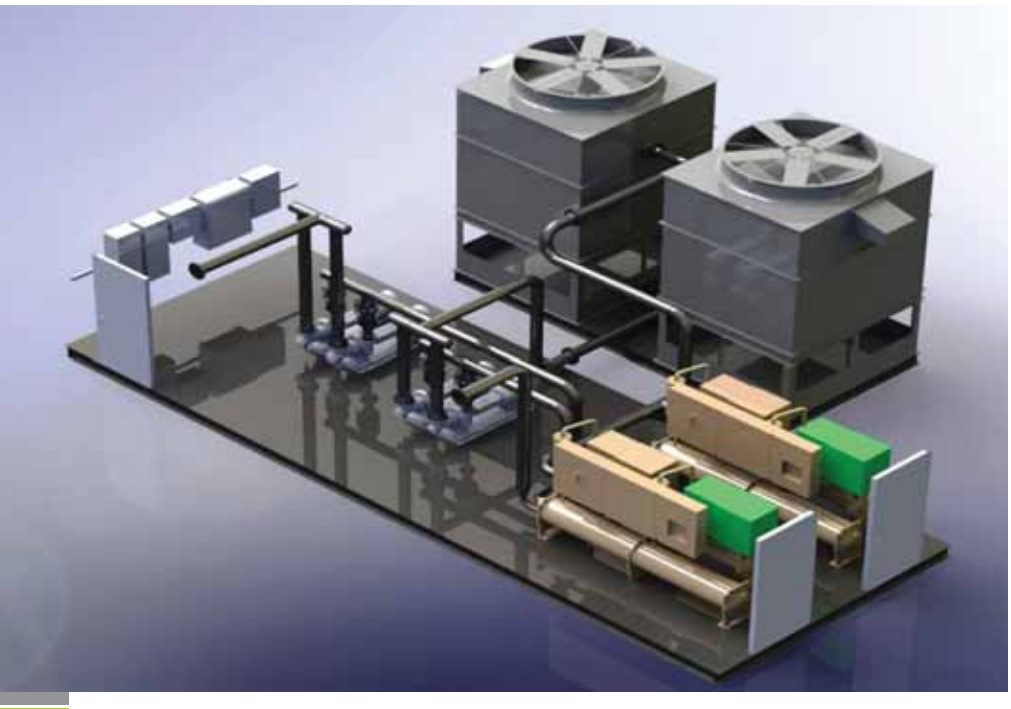
Factors such as increasing construction activities predominantly due to upcoming events such as Qatar FIFA World Cup 2022, Dubai Expo 2020, and FIFA World Cup 2026 as well as replacement of conventional chillers is projected to drive the market over the forecast period

The global chiller market was valued at $7.1 billion in 2018 and is anticipated to register a CAGR of 4.9 per cent during 2019-2024. Factors such as increasing construction activities predominantly due to upcoming events such as Qatar FIFA World Cup 2022, Dubai Expo 2020, and FIFA World Cup 2026 as well as replacement of conventional chillers is projected to drive the market over the forecast period.

Chiller Market

Based on type, the chiller market is segmented into screw, scroll, centrifugal, reciprocating, and absorption, of which the screw chiller category witnessed the highest revenue share in 2018. APAC and North America predominantly in the US, and China recorded the largest revenue share, respectively in 2018, owing to increased hotel construction projects. On the other hand, the absorption chiller category has gained traction in recent years which is primarily attributed to the use of solar power and waste energy to power the chiller plants.

Absorption chiller is further segmented into steam, hot water, and direct-fired chillers, of which the steam absorption chiller category registered the majority of the revenue share in 2018. Steam absorption chillers have gained popularity in the industrial sector including chemical, oil & gas, and energy and utilities. In the MEA region, this trend is growing at a substantial rate. Also, the use of solar plants to supply absorption chiller with hot water for cooling applications at little or no additional cost is anticipated to drive the growth of the absorption chiller market in the coming years.



Based on end-user, the market is divided into commercial, residential, and industrial where commercial held the largest share of the chiller market in 2018. Increasing construction activities in the hospitality and transportation sectors is the major reason for the growth of this category. Transportation end-user stood at the top of the heap accounting for around 30 per cent of the chiller market. The rising number of airports and railway construction projects is driving the demand for chillers in the transportation application.

Based on the region, APAC registered increased demand for chillers in 2018, with China attributing to majority of the market share. China recorded substantial growth in its construction expenditure and is poised to exhibit significant growth in the coming years as well. Furthermore, cities such as Shanghai and Wuhan are expected to embark on the largest construction projects, further driving the demand for chillers.

Growth Drivers

Rising temperature due to global warming is driving the growth of the chiller market across the globe. Presently, with increasing greenhouse gases in the

atmosphere, more infrared energy released by the surface ends-up being absorbed by the atmosphere resulting in increased temperatures. For instance, as per the National Aeronautics and Space Administration (NASA), the global average temperature in 2017 was around 0.900 Celsius warmer relative to the 1951-1980 average temperatures. Hence, increasing global temperature is fueling the demand for cooling systems across the globe, which is further supporting the growth of the market.

Trend

The adoption of R32 refrigeration has been observed to be one of the key trends in the global chiller market owing to the enhanced operational efficiency. As R32 refrigerant efficiently conveys heat, it would reduce energy consumption around 10 per cent as compared to that of chillers using refrigerant R22. In addition, compared to the refrigerants such as R22 and R410A, R32 chillers have very low Global Warming Potential (GWP), which helps to reduce the emission of greenhouse gases in the atmosphere. Moreover, R32 chillers have a significantly higher volumetric cooling capacity than other types of refrigerants, which would help to reduce the system pipe size and increase the efficiency of chillers. Hence, owing to the growing demand for eco-friendly, and energy-efficient cooling systems, R32 chiller is trending in the chiller market.

Restraint

Alternative cooling technologies like variable refrigerant flow (VRF) system is likely to hinder the growth of the chiller market. VRF systems are capable of providing simultaneous heating and cooling during the single mode of operations. In addition, VRF systems are easy to install and need fewer connections, resulting in a lower cost of installation. Also, as VRF systems transfer the energy from cooling zones to heating zones of the building, these systems are more energy efficient than air or water-cooled chiller systems.

In addition, the VRF system has a greater ability to provide consistent heating or cooling as compared to chillers. VRF monitors each zone of the house and sends the right amount of heated or cooled air in order to maintain the temperature. As a result, demand for VRF systems are increasing and it is likely to restrain the growth of the chiller market in the coming years.

Chiller Market Competitive Landscape

Competition in the chiller market is moderately high owing to the presence of numerous manufacturers. The market is primarily characterised by four companies namely Johnson controls International PLC, United Technologies Corporation, Ingersoll-Rand plc, and Daikin Industries Ltd.

Chiller Market

Some of the major players in the global chiller market include Johnson Controls International, Samsung Electronics, Ingersoll-Rand, United Technologies Corporation, Daikin Industries, Gree Electric Appliances, Zamil Air Conditioners, Thermax Limited, Mitsubishi Electric Corporation, Petra Engineering Industries Co, S.K.M Air Conditioning LLC, and Danfoss A/S. ■

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The food processing industry has changed from a supply-driven to a demand-driven market where speed and efficiency are critical. Quality standards are changing and processing requirements have become more stringent. Gandhi Automations' engineers have over 20 years of experience dealing with specific challenges being faced by the food processing industry. The selection of doors includes sizing options for added head or side clearance, sealing options to account for pressure differences, and ability to withstand humidity changes.

Food and beverage industry is one of the biggest manufacturing sectors in India with over 4 million people employed within the supply chain and generating over Rs 100 billion for the economy each year.

Manufacturing, production, packaging and distribution facilities all require specialist doors to operate on a daily basis. Gandhi Automations has a range of doors to suit this sector.

Security, cleanliness, reliability, environmental properties are important factors while choosing doors. Gandhi Automations has specifically developed the Prime Food door to suit food markets and white wall environments, with wash down guides, stainless steel options, variable air leakage requirements, non-touch safety light curtain and high-speed operation.

The pioneer of automatic high-speed doors in India with multi-composite frame for the food industry, Gandhi Automations' Prime Food door beats any expensive, heavy and unsatisfactory weld-fabricated stainless-steel door. They anticipate the current food processes ranges.

Why Gandhi Automations' doors?

Comply with Food Safety Regulations

Food processing environment must be efficient, clean and temperature-controlled. Gandhi Automations' high performance roll up doors help to keep food products stable and fresh. The se doors keep environment hygienic with the smooth and even-textured PVC door curtain that is easy to clean. A stainless-steel structure and side posts are optional.

Conserve Energy

The rapid open or close cycle on the high performance roll up doors limit open time and minimise temperature fluctuations. These doors conserve energy costs while protecting food quality.

Gandhi Automations' superior seal that covers the full perimeter of the door keeps storage and processing areas free of contamination from drafts, dust, dirt and insects.

Need of Washability & Corrosion Resistance

The frames and mechanisms of Gandhi Automations' doors for the food processing industry are manufactured from new multi-composite materials. They are developed from the beginning to cope with the rigorous constraints of the agri-food industry, they are more corrosion-resistant than 316L stainless steel.

The bottom line is Gandhi Automations' food processing doors help to control the food storage environment, improve the flow of product and increase productivity, ensuring profitability and continuing operations.

Prime Food: Water protected

Fast roll up doors for the food industry are designed to meet the stringent demands of hygiene in the food industry. Prime Food fast roll up doors are resistant to humidity, temperature, corrosion and detergents. It is very easy to clean and disinfect. These doors are apt for tight sealing. The smooth surface with shiny finish prevents dust build up and is resistant to pressure washing. The self-repairing system automatically resets the door after an accidental impact. The robust construction of Prime Food provides high cycle operation even in wet applications. FDA approved Polystone M-Natural guides available as standard for environments that demands rigorous cleaning routines. Fast roll up Prime Food doors are very useful in FMCG sector. ■

New Ultrasonic Flow Sensor

Belimo's inline flow sensors utilises ultrasonic transit-time technology to provide accurate, repeatable measurement for any HVAC application. The innovative measurement method features patented glycol compensation logic to automatically detect, monitor and compensate the glycol concentration in the system at all times.

- Trusted flow measurement with (±) 2 per cent accuracy and (±) 0.5 per cent repeatability
- Multi-point wet calibrated to ensure accuracy and repeatability
- Only one flow sensor is required for all glycol concentration up to 60 per cent
- Low pressure drop for pump optimisation provides energy savings
- Low power consumption of 0.5 W saves energy and transformer capacity
- Accurate results without drift
- Ease of installation and energy efficiency. ■

For more information, write to info.india@belimo.ch

Luxury Residences with a Geothermal System in Milan

In the heart of Milan, a prestigious building has been given a new lease on life. It was designed by one of the masters of Italian architecture and design: Vico Magistretti. The building is in Via Leopardi 15, a few steps from Via Monti, Piazza Castello, and Cadorna Station, and is well-served by the urban transport network and houses luxury apartments made with prestigious finishing touches and equipped with the most innovative technologies.

The criteria for the design of the systems were: reduced energy consumption, high reliability levels, reduced maintenance costs, high degree of functionality, as well as, comfort for users in terms of high air quality and eco-sustainability.

In order to meet these objectives, a four-pipe centralised HVAC system was installed. It is based on 1 multi-purpose NECS-WQ0604 heat pump; 1 NECS-CN0704 heat pump and 1 EHRHH-HT / S 0302 heat pump for the production of domestic hot water up to 70C EHRHH-HT / S 0302, all Climaveneta branded. The central heating plant, managed by ClimaPRO, is connected to a geothermal field consisting of 27 depth probes (135 metres). ■

Green cooler in Japan

Panasonic has launched an evaporative cooler in Japan, which relies on an ultra-fine mist to reduce temperatures in outdoor environments. The Green air conditioner sprays an extremely fine mist with a particle size of about 10μm. This is said to ensure that the water mist evaporates quickly, reducing the feeling of wetness and achieving an efficient temperature drop.

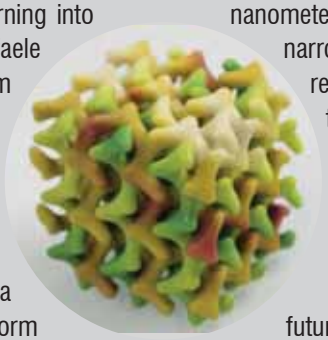
Also, by generating a swirling air flow during mist spraying, a dome-shaped cooling space with a diameter of about 2m, which is less susceptible to crosswinds. It is said that the temperature can be reduced by up to 7C.

It is also equipped with a remote monitoring and control system that can automatically control the spray according to local weather forecast data.

Units have already been installed at Odaiba Rainbow Park, a popular tourist spot that overlooks Rainbow Bridge and the sandy beach facing Tokyo Bay and at Shimbashi Station in Minato-ku, Tokyo. ■

Water that never freezes

Scientists have managed to reduce the temperature of water to within 10C of absolute zero without it turning into ice. Led by Professors Ehud Landau and Raffaele Mezzenga, a group of physicists and chemists from the University of Zurich and ETH Zurich have now identified an unusual way to prevent water from forming ice crystals, so even at extreme sub-zero temperatures it retains the amorphous characteristics of a liquid.



The researchers designed and synthesised a new class of lipids (fat molecules) to create a new form of 'soft' biological matter known as a lipidic mesophase. The lipids spontaneously self-assemble and aggregate to form membranes, behaving in a similar way as natural fat molecules.

These membranes then adopt a uniform arrangement to form a network of connected channels that measure less than one nanometer in diameter. This structure leaves no room in the narrow channels for water to form ice crystals, so it remains disordered even at extreme sub-zero temperatures. The lipids don't freeze either. Using liquid helium, the researchers were able to cool a lipidic mesophase to a temperature as low as (-)263C with no ice crystals formed. The water is described as becoming "glassy".

The research is said to be paving the way for future projects to determine how proteins might be preserved in their original form and interact with lipid membranes at very low temperatures. This new class of soft matter could also be employed in potential applications wherever water must be prevented from freezing. ■

LOUVER TYPE MIST COOLING SYSTEM

For

CHILLERS

A Superior Alternative to Cooling Tower

▲ *Louver Type MCS*

Assured Approach of 1°C to WBT.
Guaranteed Power Saving with Small Foot Print...
Not a miracle, a reality!

Other Superior Features of LTMCS

- **NO FILLS / NO FINS, NO FANS**
- Zero Maintenance due to all Non-moving parts, Choke-less Nozzle design and Special non-corrosive MOC
- Exremely easy operation
- Life of more than 15 to 20 years

Over 300 installations

Typical case study data of a 1200 TR Chiller

Sr. No.	Parameter	Cooling Tower (Induced Draft)	LTMCS
1	Wet Bulb Temperature	29°C	29°C
2	Chilled Water Temp in °C (Assumed)	5°C	5°C
3	Supply Temp. from CT / LTMCS	33°C	30°C
4	Approach to WBT	4°C	1°C
5	**ΔT for Chiller**	**28°C**	**25°C**
6	Chilled Water Compressor Motor Kw for 1200 TR	720	643
7	Energy Saved in %	-	10.7%
8	**Energy Saved in Kw**	**-**	**77 Kw/Hr**
9	Total Running Hours per Annum	8640	8640
10	**TOTAL POWER SAVED PER ANNUM**	**-**	**6,65,280 Kw**

MIST
imitating nature

Mist Ressonance Engineering Pvt. Ltd.

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