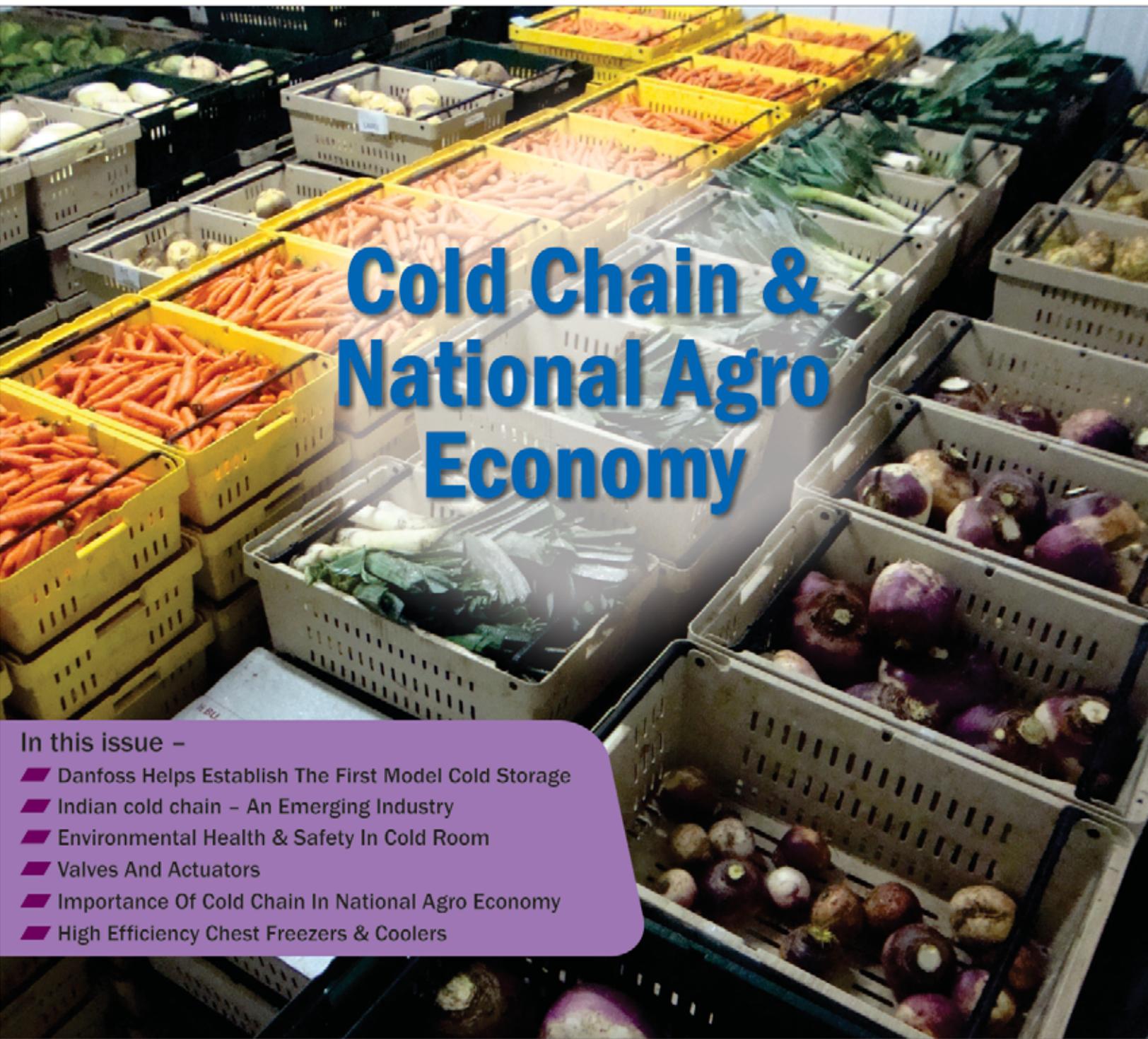


Cooling India

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Cold Chain & National Agro Economy

In this issue –

- Danfoss Helps Establish The First Model Cold Storage
- Indian cold chain – An Emerging Industry
- Environmental Health & Safety In Cold Room
- Valves And Actuators
- Importance Of Cold Chain In National Agro Economy
- High Efficiency Chest Freezers & Coolers





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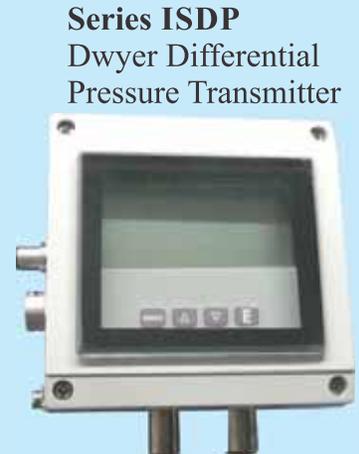
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Publisher's Letter



Publisher's Letter

Hope The Situation Changes Fast!

Can you believe that around 795 million people in the world do not have enough food to lead a healthy active life? When the figure is converted to percentage for better understanding, we see around 11.11% of the global population does not get adequate amount of food. The figures are from a report of World Food Programme (WFP). Let me quote one more figure from them: "The vast majority of the world's hungry people live in developing countries, where 12.9% of the population is undernourished."

If you have already started feeling sorry for those deprived, poor souls, some more surprising figures are waiting for you. I mean, Food and Agriculture Organization of the United Nations (FAO) communicates, "Roughly one third of the food produced in the world for human consumption every year – approximately 1.3 billion tonnes – gets lost or wasted." FAO also informs that food losses and waste amounts to roughly US\$ 680 billion in industrialized countries and US\$ 310 billion in developing countries.

The above two sets of statistics clearly portray the present global situation. Our mother world is not so unproductive; the problem arises because of either non-existing or inefficient distribution system. And it has been realized by the decision or policy makers globally. Cold storages are one of the essential elements of perishable agro products' supply chain. Thus, globally a great initiative has been taken up to construct more cold storages.

In their recent report, titled 'Cold Storage Construction Market by Storage Type (Production Stores, Bulk Stores, Ports), Application (Food & Beverages, Medical Products, Chemicals), and Region (Asia-Pacific, North America, Europe) – Global Forecasts to 2021,' MarketsandMarkets states that the global market is projected to reach USD 10.47 Billion by 2021, at a CAGR of 14.0% from 2016 to 2021.

The report also communicates a good news for us to cheer. It states that Asia-Pacific was the largest market for cold storage construction in 2015, owing to the increasing demand of cold storage construction in developing economies such as India and China. Companies in this region are investing to develop and operate innovative and cost-competitive cold storage constructions. India, China and Japan are the region's top cold storage construction players.

According to a report by Emerson Climate Technologies India, we are the world's 2nd largest producer of fruits and vegetables and we throw away fresh produce worth INR 133 billion every year because of the lack of adequate cold storage facilities and refrigerated transport... 'Hope the situation changes fast!

Please send your comments at pravita@charypublications.in

Pravita Iyer
Publisher & Director



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Sanjog Belatkar

Senior Manager Sales,
Technical Department,
CAREL ACR Systems Pvt. Ltd.

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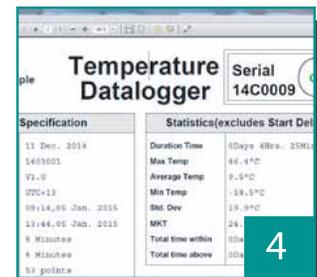
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FROM THE EDITOR



Are Your Doors And Windows Properly Insulated?

Doors and windows are the common parts of any air-conditioned area through which air leakage takes place. In any temperature-controlled zone, leakage of air means fast leakage of energy (applicable in both ways/directions). So, if leakage continues for a prolonged period of time, the energy consumption increases proportionally.

Thus, air leakage is an incident that actuates mounting of the cost of operation, and obviously, once noticed, it needs to be controlled as soon as possible. There are cases where even more than 25 to 30% reductions of the energy bills have been achieved just by air leakage control.

When we delve into the reasons behind air leakage, we often find some very common yet highly neglected causes. For example, there may be cracks, gaps and holes in the enclosing walls. However, doors and windows, more specifically doors are often found to be the main leakage points. In air-conditioned spaces windows are often kept nicely sealed and secured. But doors are repeatedly opened and closed, also there are vibrations in frames.

As normally, the air pressure is higher inside, the chance of outward air leakage is more in any enclosed system. Contextually, a report from the US Dept of Energy highlights, "One of the most common air conditioning problems is improper operation. If your air conditioner is on, be sure to close your home's windows and outside doors. For room air conditioners, isolate the room or a group of connected rooms as much as possible from the rest of your home."

So, when we look at it from the comfort angle, we find, a well-insulated home makes its occupants more comfortable. The comfort is physical as well as economical. Now, the question is how to find out whether there is leakage in your enclosed space. The first step is to do a physical inspection. Check both the interior as well as the exterior part thoroughly. Old caulking around the door or windows are often found to be damaged. Identification of air-leak-channels and insulation defects can easily be done with the thermographic imaging technique.

Pl. send your views at pkchatterjee@charypublications.in

“
Air leakage needs to be controlled in air-conditioned areas. Identification of air-leak-channels and insulation defects can easily be done with the thermographic imaging technique...



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Indian HVAC market is expected to witness boom time by 2019

According to a recently published report by TechSci Research, titled, "India HVAC Market Forecast and Opportunities, 2019", the HVAC market in India is forecast to reach USD3.97 billion by 2019. Growth in retail, hospitality and commercial sectors is significantly boosting the demand for such systems in the country, as these sectors involve large-scale application of HVAC systems in organized retail outlets, shopping complexes, hotels etc.

Moreover, with anticipated growth in FDI (Foreign Direct Investment), several international players are expected to enter and start operations in the Indian retail market. Driven by strong FDI inflow from multinational food processing companies, the retail market in India is projected to reach USD726.62 billion by 2019, which is expected to further fuel the country's HVAC market.

The room air conditioning segment captured majority revenue share in Indian HVAC market in 2013, and is expected to retain its dominance by 2019. This is largely due to portability; ease of installation and less space requirement of room air conditioning systems. Centralized air conditioners, in contrast, are comparatively costlier and are usually preferred for large commercial or office spaces, where more tons of refrigeration is required for effective cooling. Consequently, segment share of room air conditioners in the Indian HVAC market is expected to increase over the next five years on account of several residential projects coming up in the forthcoming years.

"The Northern region has been leading the HVAC market in India, with high revenue contribution from Delhi-NCR. In 2013, real estate market in Delhi-NCR grew by 22.5%, leading to high growth in the HVAC market, in volume plus value terms. Rapid infrastructure development activities have been witnessed in cities such as Gurgaon, Noida, Greater Noida and Chandigarh in recent year. Further growth in real estate sector in these cities is expected to spur the market for HVAC systems in Northern India," said Karan Chechi, Research Director with TechSci Research, a research based global management consulting firm.

HVAC systems are becoming one of the key building blocks in modern infrastructure. These systems are found in almost all upcoming commercial as well as residential buildings. Rise in infrastructure, rapid urbanization and growth in commercial properties are some of the key factors fuelling the market for HVAC systems in India. ■

Samsung establishes new European sales office

Samsung Electronics has established the Samsung Electronics Air Conditioner Europe (SEACE) in Amsterdam, the Netherlands, which will begin operations in January 2017. SEACE, a dedicated sales office for ACs in Europe is expected to solidify the sales activities, which have been previously operated by each office across 17 European countries. The move comes as part of Samsung's larger efforts to expand its AC business in the European market. The company estimates that Europe is the 2nd largest B2B air conditioning market in the world – it has shown steady growth of \$3.6 billion this year, which is forecasted to increase to \$4.2 billion by 2020.



Byung-sam Suh

Byung-sam Suh, Head of Digital Appliances Business at Samsung Electronics, said, "Our innovative, world leading air conditioning solutions, including the 360 Cassette, with its structural beauty and innovation, have been recognised as game-changers in the system air conditioner market." ■

SOE offers accreditation to Carrier Transicold UK's course

Carrier Transicold UK's Training Academy programme secured accreditation as a Continuing Professional Development Course from the Society of Operations Engineers (SOE) – an industry body working to ensure high standards in engineering education. Carrier Transicold, which operates in the UK as Carrier Transicold (UK) Limited, is a part of UTC Climate, Controls & Security, a unit of United Technologies Corp.

Launched in September 2015, the Training Academy's mission is to ensure a steady flow of new talent into the company's service partner network. Each service partner is an independent company, providing service for Carrier Transicold equipment.

The SOE accreditation further raises the profile of the Training Academy programme, and will help in attracting an ever-increasing pool of new talent into the industry.

"We are pleased that our dedication to high standards in engineering education is now recognised with industry accreditation," said Andy Wainwright, Service Director, Carrier Transicold UK. ■

Australia implements ISO standards for refrigeration safety

Strong industry and government engagement has seen Australia adopt international (ISO) standards for refrigeration safety. These documents supersede the AS/NZS 1677 series. The changes were first proposed by AIRAH (the Australian Institute of Refrigeration, Air Conditioning and Heating) in 2010.

Significant changes have been made to refrigeration standards, with the following now published and available:

- AS/NZS ISO 817:2016, Refrigerants – Designation and safety classification
- AS/NZS 5149.1:2016, Refrigerating systems and heat pumps – Safety and environmental requirements – Part 1: Definitions, classification and selection criteria
- AS/NZS 5149.2:2016, Refrigerating systems and heat pumps – Safety and environmental requirements – Part 2: Design, construction, testing, marking and documentation
- AS/NZS 5149.3:2016, Refrigerating systems and heat pumps – Safety and environmental requirements – Part 3: Installation site
- AS/NZS 5149.4:2016, Refrigerating systems and heat pumps – Safety and environmental requirements – Part 4: Operation, maintenance, repair and recovery.

AIRAH's Executive Manager – Government Relations and Technical Services Phil Wilkinson, F.AIRAH, said, "The adoption of these standards is a really important step as the HVAC&R industry transitions to a low emission future."

AIRAH CEO Tony Gleeson, M.AIRAH, said, "PRIME, the HVAC&R industry strategy to transition to low emissions, identified very early on that AS/NZS 1677 needed to be reviewed. In response to stakeholders' needs Standards Australia worked closely with industry and government, and supported PRIME to achieve this major milestone."

AIRAH has a long and proud history of representing an industry of professionals, who are of fundamental, and increasing, importance to the comfort, health and safety of the community. Formed in 1920, AIRAH is recognised by government and industry bodies for its expertise across a wide range of issues in the area of engineering services for the built environment. ■

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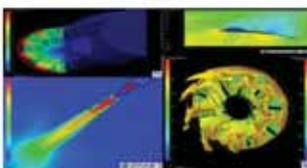
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Aspen Pumps celebrates recognition earned through the twelfth RAC cooling industry award

Aspen Pumps has celebrated winning a prestigious Cooling Industry Award for its innovative Micro-v i⁴. This intelligent Air Conditioning (AC) condensate pump beats off extensive competition to win the Air Conditioning Product of the year: Accessory, Component or Process' category. Now in its 12th year, the RAC Cooling Industry Awards champions the leading innovations and environmental successes in the refrigeration and air conditioning industry.

Featuring integrated i⁴ technology, the Micro-v i⁴ is the next generation of mini pump. Designed specifically to simplify installation and maintenance, while offering a wide raft of smart features, the Micro-v i⁴ ticks all the right boxes for AC engineers.

The Micro-v i⁴ reliably and efficiently removes condensate from AC units while avoiding installation and maintenance issues.

Suitable for high wall split systems, ducted units and floor standing and chassis AC units, the pump is ideal for installing directly inside the AC unit. The Micro-v i⁴ is the first pump available that combines integrated i⁴ technology with the convenience of a floatless sensor that is immune to contaminant build up and is both small and powerful whilst being quiet and reliable.

Made up of four intuitive technologies that all work harmoniously to provide a total system approach, i⁴ technology features Pulse technology that gives a visual indication about correct installation of the pump; Hydrotech technology which collects data and adjusts switching levels and motor speed, depending on the flow rate; and in-built Silent+ and Univolt technology so the pump is controlled on demand, with the i⁴ Technology offering a soft start as standard, leading to truly quiet running. ■



A view of RAC award ceremony...

Danfoss celebrates its two decades of 'Manufacturing in China'

Danfoss has recently celebrated the company's 20-Year Manufacturing in China at its Wuqing Campus, the first manufacturing facility of Danfoss in China.

The company has also announced the inauguration of a new DCS Lab and a new heat meter product line at the campus. The new lab will focus on the developing and certifying of compressors with LGWP refrigerants that are more environmental friendly, in support of the growing needs for 'green solutions' by the Danfoss customers.

The heat meters to be produced by the new product line will be applied to measure thermal consumptions in newly developed and existing buildings, providing strong support to the government's building energy efficiency initiatives.

The two new facilities showcase Danfoss' long-term commitment to the Chinese market, and will further strengthen the company' innovation and manufacturing capacities to better serve customers in China.

Currently, the company is operating in three major manufacturing campuses in Wuqing of Tianjin, Haiyan of Zhejiang and Anshan of Liaoning with a national sales and distribution network supported by 13 sales offices across the country. ■



A view of the gala...

Emerson reveals its National Distribution Agreement

Emerson has revealed that it has finalised a national distribution agreement with United Refrigeration. United Refrigeration is a well known wholesale distributor of refrigeration, HVAC and food retail products throughout North America.

With over 400 locations backed by regional distribution warehouses, the company provides convenient access to products and technical expertise for HVAC/R contractors and their customers.

This agreement authorises all United Refrigeration locations to sell Emerson's full line of Copeland products.

This was reached in order to better serve the needs of refrigeration and air conditioning contractors nationwide (in North America).

John Rhodes, President, Refrigeration, Emerson Commercial & Residential Solutions, said, "We recognise the need to expand our position with high-performing, growth-oriented wholesalers who are well-aligned with Emerson's business objectives and have the capability to meet the challenge of changing industry dynamics." ■

Fujitsu partners with UK's HVAC&R distributor TF Solutions

Fujitsu, a well known provider of innovative, reliable and energy efficient air conditioning products, has partnered with TF Solutions, UK's renowned air conditioning and refrigeration distributor, to open a new training facility dedicated to its air conditioning sector at TF Solutions' Burton-on-Trent branch.

The new Burton-on-Trent training centre was officially opened on the 19th October, by TF Solutions' Managing Director, Mike Sanderson, with IOR President, Steve Gill, in attendance.

Mike Sanderson, TF Solutions' Managing Director, said, "We have a long partnership with Fujitsu and are pleased to collaborate with them to bring a dedicated training centre to our customers in the Midlands and beyond."

"Our mission statement for TF Solutions when we started back in 2001 was 'working together for success' and it is this same principle that has allowed us to remain a vital part of our customer's successes over years. Training is an essential element in helping our customers to grow and develop, so we are now proud to be working together with Fujitsu for everyone's success," he further added.

Steve Gill, the IOR President, said, "As someone from the Midlands, I am delighted that Fujitsu and TF Solutions have partnered to make the training centre here at Burton possible. Having a local centre will enable more to attend. The IOR supports and encourages skills development through training, so I'm delighted to be here today to see these excellent well equipped training facilities."

The new Training Centre is the latest investment from The Ice Men following on from TF Solutions' recent re-location to its state-of-the-art facilities in Burton, boasting enhanced office space, improved storage facilities and a fully stocked trade counter featuring all the latest Fujitsu air conditioning equipment and ancillaries. ■



(L2R) Mike Sanderson with Steve Gill opening the centre...

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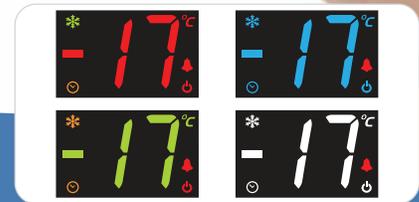
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Honeywell introduces new low-global-warming refrigerant

Honeywell has started marketing Solstice L40X, a refrigerant suitable for medium- and low-temperature standalone applications – such as hermetically sealed systems in refrigerated plug-in type-cabinets. Solstice L40X provides up to 3% higher capacity and up to 6% better efficiency at low temperature than the current, widely used refrigerant R-404A.

By 2022, the European Union's F-gas regulations will ban the use of refrigerants with Global-Warming-Potential (GWP) greater than 150 in airtight container applications – such as plug-in and refrigeration condensing units.

Solstice L40X has a GWP of 146, which is more than 96% lower than R-404A. This also has a lower risk of flammability compared to other refrigerant options such as propane, whose usage in such applications is limited to small amounts and can incur extra costs.

Solstice L40X (R-455A) is rated A2L by ASHRAE. Leading hermetic compressor manufacturers have validated the performance of Solstice L40X in tests over the last 18 months – and have found similar capacity and discharge temperature, but with improved efficiency, when compared to R404A. Solstice L40X can be used across many segments of the HVAC&R industry, including small charge, plug-in type cabinets, condensing units and monoblocks for cold rooms and freezer rooms, small chillers, heat pumps and chillers.

Honeywell's family of Solstice-branded products includes refrigerants for stationary, commercial refrigeration and mobile refrigerants, liquid and gaseous blowing agents, solvents and propellants – all based on Honeywell's hydrofluoro-olefin (HFO) technology that helps customers lower their carbon footprint without sacrificing end-product performance. ■



Midea completes the Clivet acquisition process

Recently there was a ceremony centering around completion of the acquisition of 80% of Clivet S.p.A., Clivet España S.A. and related real estate assets by Midea Group Co., at Clivet's headquarters in Feltre (Belluno). Midea had entered into a Definitive Agreement (DA) to acquire 80% stake of Clivet S.p.A., Clivet España S.A. and related real estate assets. As of October 31, 2016, all the condition precedents of the DA were satisfied, and the relevant regulatory approvals were obtained.

Paul Fang, Chairman and President of Midea, said, "Today marks a major step forward towards an industrial partnership between Midea and Clivet. We look forward to leveraging on our complementary resources and capabilities to fully realise the potential of the partnership. We believe our continuous investment in the brand, technology, marketing and people and unwavering commitment to product quality."

Eric Tian, President of Midea Commercial Air Conditioning Division, said, "Through this win-win strategic alliance, Midea will further reinforce its presence on the European markets and explore growth opportunities together with Clivet." ■

INFICON teams up with LeakMaster

LeakMaster of Evansville, Indiana, has worked with INFICON, a well known provider of leak-detection equipment for the auto industry, to develop a system that accurately tests filler pipes quickly and efficiently, while at the same time using much lower concentrations of tracer gas than more expensive vacuum-chamber systems.

The move to capless fuel fillers has been driven by the auto industry's need to meet stricter LEV II clean air regulations for passenger cars and light trucks that go into effect in 2017.

In the new LeakMaster system, a technician places the filler pipe into a test station. Position sensors then automatically guide connections to the component. Pressurised He gas is pumped into the test piece and an INFICON T-Guard sensor is used to test for leaks by measuring gas that escapes into a 2-foot by 5-foot test chamber. The cycle time for each test is 40 secs or less.

Thomas Parker, INFICON's Automotive Sales Manager for North America, said, "The LeakMaster's test system is completely automated and provides cycle times and reliability equal to more elaborate vacuum-chamber testing at half the cost." ■

MIRAI INTEX showcases its air cycle technology at Chillventa

A Swiss engineering company MIRAI INTEX has introduced the air cycle technology for the first time at Chillventa 2016 in Nuremberg. The stand with two flagship models of air cycle HVAC&R equipment attracted a lot of attention. Many stand visitors noted that the air cycle technology had a number of benefits and the recent developments in this field made the air cycle machines one of the main innovative products at the exhibition.

The 'MIRAI Cold' air cycle machine solves the problem of refrigeration in the temperature range of -40°C to -80°C. The technology will provide effective refrigeration in areas such as storage of biological materials in biobanks or preservation of premium quality food products.

Moreover, recently at Chillventa Technical Programme, the company has presented the revolutionary safe HVAC system with natural air as a refrigerant.

The 'MIRAI Climate' air-cycle HVAC solution has been introduced for the first time to the European community – not only under the aspect of its eco-friendly technology, but also high productivity with minimum energy expenditure.

As per the available information, MIRAI maintains a young team dedicated to the protection of the environment through the implementation of innovative technologies. With innovative solutions based on air cycle technology and achieved through advanced scientific and technological developments, the company provides environmentally friendly equipment aiming to make this world a better place to live in.

The depletion of the ozone layer and global warming have posed new requirements on industrial equipment, which have lead them to develop units that operate with natural air instead of harmful Freon gases. MIRAI INTEX supplies off-the-shelf equipment, as well as the several engineering services. ■



A view of the MIRAI INTEX's stall at Chillventa...

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Toshiba supports UK's top air conditioning students

Toshiba has organised a programme of training courses around the country to help students prepare for their participation in the national SkillFRIDGE finals, which take place at the NEC in November. The programme covers technical knowledge and practical skills in relation to residential and light commercial air conditioning, including installation, servicing and maintenance.

Students successfully completing the course will gain an industry-recognised Toshiba qualification, supported by a training card with a unique registration number. Students will add this number to their commissioning sheets in the competition as proof of competence.

A total of six student finalists will provide vital support in the month being held at The Skills Show, NEC, competition judges are invited candidate's college tutors.



David Dunn

attend the training sessions, timed to leading up to the SkillFRIDGE finals, on 17-19 November. SkillFRIDGE to attend the courses along with

As lead sponsor for SkillFRIDGE, Toshiba is also providing the test rigs that will be used in the finals competition. The rigs are based on fully functioning Toshiba digital inverter or super digital inverter air conditioning split systems.

David Dunn, Director and General Manager of Toshiba and CIAT Ozonair, said, "SkillFRIDGE is a fantastic initiative that incentivises and rewards trainees – the industry's standard bearers and potential leaders of tomorrow – in pursuit of excellence. We are delighted to be involved and will be giving the events our wholehearted support. As a global leader in high efficiency, high performance air conditioning, a key part of our role is to support and encourage the industry to improve the level of knowledge and technical skills. It is obviously in everyone's interests to raise the bar, from the quality of design and installation through to commissioning and ongoing servicing and maintenance throughout the equipment life-cycle. Toshiba is committed to raising standards, and we have invested in a national network of air conditioning training centres to provide high quality technical and hands-on training for customers. Our support for SkillFRIDGE underlines the importance we attach to raising competence standards." ■

Precision introduces new HC Refrigeration System

Precision is an independently-owned UK manufacturer of commercial refrigeration for the food-service industry. Its new R290 Hydro Carbon (HC) Ref. Sys. used in the cabinets offers the best in energy efficiency and environment protection, with a GWP of just 3 - compared to 1430 with R134a or 3922 with R404A. An even temp is ensured internally throughout the cabinet, regardless of product loading, due to the internal rear-mounted airflow duct.

All Precision uprights are engineered to work in the toughest, busiest and hottest kitchen environments, up to 43°C. Their controls offer the flexibility to safely store meat, fish or general produce with internal temperatures of -2 to +4°C. They also have hot gas rather than off-cycle defrost, eliminating the risk of evaporator ice build-up, even in high ambient temperatures.

Precision's cabinets feature a fully splash-proof LCD display to easily adjust the temperature or turn off power. They are packed full of energy-saving features, and the standard high / low audio-visual alarms and a RS485 port for optional connection (wifi or cable) to temperature monitoring / recording software for enhanced HACCP compliance. ■

Ductless Heating & Cooling Systems Market will grow

According to a report published by MarketsandMarkets, the global ductless heating & cooling systems market is to reach USD 78.62 Billion by 2021, at a CAGR of 8.18% from 2016 to 2021. This growth is fueled by the high potential demand from residential buildings and the increasing global demand for ductless heating & cooling systems in the Asia-Pacific, South American and Middle-Eastern and African regions.

Ductless heating & cooling systems are preferred over conventional systems because of their low energy consumption and easy installation procedure.

The split system is the most-widely used type of ductless heating & cooling system. This allows the user to control the temperature of individual zones according to need, giving the user the flexibility of operation and savings in operating cost. The major benefit of the split system is the low noise level of the system.

The Asia-Pacific region is the largest market in the global ductless heating & cooling systems market, in terms of value, and this trend is expected to continue till 2021. ■

Schneider, Panasonic develop integrated BMS solution

Schneider Electric, a specialist in energy management and automation; along with Panasonic Corporation, a leader in the development of diverse electronics technologies and solutions; has come out with an integrated HVAC equipment and Building Management System (BMS) that brings new levels of HVAC control and energy efficiency to today's commercial buildings. Both companies have developed a new interface wireless solution, which enables direct serial communication between Schneider Electric's BMS and room controllers with Panasonic's Variable Refrigerant Flow (VRF)-based HVAC systems via the ZigBee wireless communication standard.



Launch of the developed solution...

This integration allows building owners and managers to view all of their core building systems including HVAC equipment, lighting, security, power and electrical distribution anytime and anywhere via a single interface and delivers actionable insights to reduce energy consumption and drive savings. The joint Schneider Electric/Panasonic solution can be installed wirelessly – which preserves existing infrastructure and is ideal for retrofits of older buildings – or it can be wired. The solution takes full advantage of innovative plug-and-play technology that simplifies system configurations for extensive VRF systems – or it can be installed as a part of a standalone system. This makes it easy to install and allows system integrators to save time and costs on installation. In addition, facility teams have access to comprehensive energy reports and dashboards as well as Schneider Electric and Panasonic's expert technical support teams to ensure that all systems are running at the highest performance levels at all times.

Schneider Electric's SmartStruxure BMS maximizes building efficiency and reduces operating costs across the entire lifecycle of a facility by integrating customized hardware, software, engineering, installation and services to ensure facilities are energy efficient and effectively managed. Panasonic's VRF system (ECOi/FSV) is designed to dramatically increase energy efficiency by delivering the highest ESEER rating in all outdoor capacities, as well as high efficiency for part-load operations that accurately match the environment in which it is being used. ■

CONGRATULATIONS to all the Emerson Cup winners!

Thank you for making it happen.

There were many reasons to celebrate the Emerson cup 2016 Awards Night. It showed us the immense reservoir of creative talent that is our industry. It highlighted the fact that the gifted minds of our generation, are willing to strive hard to make a difference. And it also showed us that the industry can come together as one to support these brilliant minds. The Emerson Cup is proud to be associated with this level of commitment and genius. A big Thank You to all who made it possible.



Follow us on :





André Borouchaki

He will be setting up and driving a world-class, strategic technology approach...

Danfoss creates new position to set strategic direction within technology

André Borouchaki has been appointed to take up the position as Head of Technology. He will report to Danfoss COO Kim Fausing. As part of the new role, he has joined the Innovation Board – and he will also be the Principal Technology Advisor to the Danfoss Leadership Team.

André will be setting up and driving a world-class, strategic technology approach together with the company's four segments to further enable the company to source and develop new technology, and to strengthen innovation and differentiation in the markets.

He comes from a position as partner in GreenFlex, a strong leading start-up specialised in consulting and services around Sustainability Strategy & Energy Efficiency. Prior to Greenflex, André spent 19 years at Schneider Electric, holding different Senior Management positions within Strategy & Innovation and R&D management, with a particular focus on software innovation.

He began his career in Alstom in 1988 and was successively in charge of different R&D projects for software systems in trains. He is a Software Engineer and graduated from Polytechnique France & Telecom Paris. ■



Gary Babcock

He will oversee planning, coordination and execution of multiple client projects...

Gary Babcock becomes Assistant Project Manager of PSI

Piping Systems, Inc. (PSI), a well known mechanical contractor and piping solutions provider in Southeastern Massachusetts and Rhode Island, has promoted Gary Babcock to Assistant Project Manager. With Piping Systems since 1995, Babcock will oversee planning, coordination and execution of multiple client projects from start to finish.

He holds multiple certifications in both Massachusetts and Rhode Island, including a Journeyman and Master Plumber license, a Journeyman Pipe Fitter license, a Journeyman Sprinkler Fitter license, and a hoisting license.

Pauline Lally, Owner of Piping Systems, said, "Gary is a great example of what we look for at PSI. He's a hard worker, and someone who has invested his time in

becoming a master of his trade. As a foreman for us, he oversaw a lot of our larger projects to completion, and he's always had a sense of pride in getting the job exactly right and making our customers happy."

Since 1971, PSI has been a one-stop piping solutions provider dedicated to making their customers the center of their universe.

Gary said, "Over the past two decades, I've always appreciated the company's philosophy and Pauline's mentality when it comes to customer service. In addition to my on-the-job experience, I've put in a good seven or eight years in night school to get to where I am, and Pauline has always been there to support me. This is just another step in my career at Piping Systems and I'm happy for the opportunity and the new challenges." ■



Joe Trauger

He will direct AHRI's federal, state and global lobbying efforts...

Joe Trauger takes over as AHRI's Senior Vice President

The Air-Conditioning, Heating, and Refrigeration Institute (AHRI) has recently appointed Joe Trauger as the association's Senior (Sr.) Vice President (VP) of Policy and Government Relations. He will join the AHRI team from December 1, 2016.

Joe is currently Vice President of Government Relations at the National Association of Manufacturers (NAM), where he is that organisation's Senior Lobbyist before Congress and the Administration. He will direct AHRI's federal, state and global lobbying efforts, and will also be a key part of AHRI's efforts in the regulatory arena.

Trauger has more than 10 years of experience on Capitol Hill, both as a Staff Member for a U.S. Senator and several Representatives and also in the House

Leadership as the Senior Policy Adviser in the offices of the majority leader and majority whip. He also worked with the House Energy and Commerce, Ways and Means, and Education and the Workforce Committees; and with the Senate Health, Education, Labour, and Pensions Committee and the Senate Finance Committee.

AHRI President and CEO Stephen Yurek said, "Joe brings a wealth of association, lobbying, and legislative experience to AHRI. Our member companies are involved in a variety of issues on Capitol Hill and in several federal agencies. We are looking forward to having someone with Joe's breadth of experience leading our government relations efforts as we welcome a new Congress and a new administration to Washington." ■

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You Still can't beat the System when it's all FRICK INDIA

B&G Suction Diffuser Plus receives 2016 Product of the Year recognition

For the sixth time since 2010, Xylem Inc., a global water technology company focused on solving the world's most challenging water issues, and its Bell & Gossett (B&G) brand, have received a Product of the Year recognition, most recently for the B&G Suction Diffuser Plus by Consulting-Specifying Engineer (CSE) magazine. The Suction Diffuser Plus is an innovative flow-straightening centrifugal pump accessory that helps maintain efficiency, improve flow conditions and eliminate recirculation zones, reducing energy waste.

The annual Product of the Year program was established to



Mark Handzel



B&G Suction Diffuser Plus with PT ports and cover...

provide CSE readers with information about the leading new products in the HVAC, fire/life safety, electrical and plumbing systems engineering markets. This year, readers, many of whom are daily product users, recognised the market-leading B&G Suction Diffuser Plus with a Bronze Award in the HVAC category.

Mark Handzel, Vice President, Product Regulatory Affairs, and Director, HVAC and Commercial

Buildings, Americas, Xylem, said, "We are pleased that CSE readers acknowledged the energy efficiency benefits, quality and reliability of the Suction Diffuser Plus and nominated it as one of the best new products of 2016." ■

Carrefour bags the "Trust and Sharing" social dialogue award

The Carrefour Group has picked up the "Trust and Sharing" social dialogue award. The prize has been awarded by the RH&M Group in recognition in particular of the successful negotiation and signing of an international agreement with trade union UNI Global Union promoting "social dialogue, diversity and respect for fundamental rights at work."

Carrefour – represented by its CEO Georges Plassat – and trade union Federation UNI Global Union – represented by its General



Jean Luc DELENNE, Director of Social Relations Carrefour and Mathilde Tabary, Director of Social Development and Diversity at Carrefour are receiving the award...

Secretary Philip Jennings – signed the international agreement in October 2015 in the presence of Guy Ryder, Director-General of the International Labour Organisation (ILO).

This global agreement will be implemented over a period of three years at Group level. This also replaces the previous one that was entered into with UNI Global Union back in 2001.

It sets out to encourage:

- pursuit of an ongoing, constructive social dialogue;
- diversity and equal opportunities in the workplace through joint initiatives, particularly in relation to gender mix and non-discrimination;
- the defence and respect of workers' fundamental rights – freedom of association and principles of collective-bargaining – as well as their safety and their working conditions at Carrefour and at its suppliers' and franchisees' premises. ■

Karlsruhe University of Applied Sciences presented the Valerius Fünér Prize

Representatives of Karlsruhe University of Applied Sciences again presented the Valerius Fünér Prize at the Bitzer trade fair stand at Chillventa 2016. The primary sponsor of the award was, The Schaufler Foundation. This year's award went to two exceptional mechanical engineering students with a focus on refrigeration and air conditioning.

Karlsruhe University of Applied Sciences is highly committed to educating its students. In the discipline of mechanical engineering with a focus on refrigeration, air conditioning and environmental technology, especially successful



A view of the award ceremony at the Bitzer trade fair stand at Chillventa 2016...

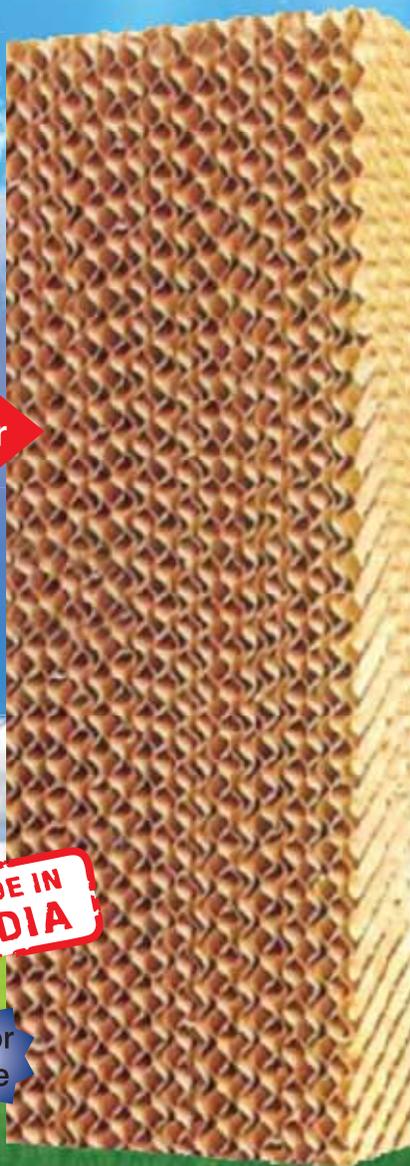
graduates have been receiving awards for some time now – including the Valerius Fünér Prize since 1981.

This year's award ceremony was held at the stand of compressor specialist Bitzer on the first day of the Chillventa trade fair. The best in their year, Marius Henne and Tobias Wurz have both earned a Bachelor's Degree at Karlsruhe University of Applied Sciences – and are now studying for a Master's Degree. Each of the two students received a very good final grade of 1.3 for their course.

Marius Henne is spending some time abroad and was unfortunately unable to take part in the ceremony. ■

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Testing The Bioweapon Defense Mode

Inspired by the air filtration systems used in hospitals, clean rooms and the space industry, they developed a HEPA filtration system capable of stripping the outside air...



A Model X was placed in a large bubble contaminated with extreme levels of pollution...

Air pollution has a significant and pervasive impact on public health. According to the World Health Organization (WHO), it is now considered "the world's largest single environmental health risk," with more than three million people dying every year as a result. This is more than twice the number of people that die in vehicle accidents each year.

Health and safety are important to Tesla Motors. According to WHO, average annual PM2.5 (particulate matter 2.5) levels (the most dangerous form of pollution) reach $56 \mu\text{g}/\text{m}^3$ in Beijing, $25 \mu\text{g}/\text{m}^3$ in Mexico City, $21 \mu\text{g}/\text{m}^3$ in Hong Kong, $20 \mu\text{g}/\text{m}^3$ in Los Angeles, $20 \mu\text{g}/\text{m}^3$ in Berlin, $17 \mu\text{g}/\text{m}^3$ in Paris, and $16 \mu\text{g}/\text{m}^3$ in London. Based on the findings of a 2013 study conducted at Harvard, these levels of pollution would result in population-averaged life expectancy reductions of 23 months in Beijing, 10 months in Mexico City, 9 months in Hong Kong, 8 months in Berlin and Los Angeles, and 7 months in Paris and London.

Just as they've designed Model S and Model X to avoid collisions or protect their occupants when one happens, they felt compelled to protect them against the statistically more relevant hazard of air pollution.

Inspired by the air filtration systems used in hospitals, clean rooms and the space industry, they developed a HEPA filtration system capable of stripping the outside air of pollen, bacteria and pollution before they enter the cabin and systematically scrubbing the air inside the cabin to

eliminate any trace of these particles. The end result is a filtration system hundreds of times more efficient than standard automotive filters, capable of providing the driver and his/her passengers with the best possible cabin air quality – no matter what is happening in the environment around them.

The air filtration system was put to the test in real-world environments from California freeways during rush hour, to smelly marshes, landfills and cow pastures in the central valley of California, to major cities in China. They wanted to ensure that it captured fine particulate matter and gaseous pollutants, as well as bacteria, viruses, pollen and mold spores.

They then decided to take things a step further and test the complete system as they would on the road, but in an environment where they could precisely control and carefully monitor atmospheric conditions. A Model X was placed in a large bubble contaminated with extreme levels of pollution ($1,000 \mu\text{g}/\text{m}^3$ of PM2.5 vs. the EPA's 'good' air quality index limit of $12 \mu\text{g}/\text{m}^3$). They then closed the falcon doors and activated Bioweapon Defense Mode.

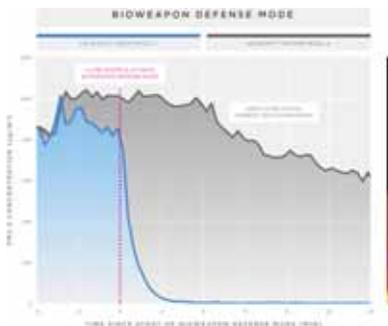
The plot (Graph 1) shows the subsequent evolution in pollution levels inside the vehicle and inside the bubble. In less than two minutes, the HEPA filtration system had scrubbed the air in Model X, bringing pollution levels from an extremely dangerous $1,000 \mu\text{g}/\text{m}^3$ to levels so low as to be undetectable (below the noise floor) by their instruments, allowing them to remove their gas masks and breathe fresh air while sitting inside a bubble of pollution.

Not only did the vehicle system completely scrub the cabin air, but in the ensuing minutes, it began to vacuum the air outside the car as well, reducing PM2.5 levels by 40%. In other words, Bioweapon Defense Mode is not a marketing statement, it is real. You can literally survive a military grade bio attack by sitting in your car.

Moreover, it will also clean the air outside your car, making things better for those around you. And while this test happened to be done with a Model X, the same would be true of the new Model S now in production.

Tesla will continue to improve the micro-geometry and chemical passivation defenses in the primary and secondary filters, which are easily replaceable, so this will get better the longer you own your car. Suggestions for improvement are welcome by Tesla. ■

(Adopted from Tesla Team's communication)



The subsequent evolution in pollution levels inside the vehicle and inside the bubble...

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Danfoss Helps Establish The First Model Cold Storage

The storage conditions of the goods are kept at an optimal level for minimum weight loss. Each room is monitored and visualised on a full-screen Danfoss System Manager enabling smart optimisation...

Cold storage expert Sabharwal Food Industries Pvt. Ltd. teamed up with Danfoss India, a leading provider of technology that engineers a better tomorrow, to set up the first Green cold storage model at Roshan Frozen and Cold Storage (Group Company), facilitating high-quality food safety and minimal food loss from farm to consumer.

The model cold storage facility, a first of its kind, is designed to European standards, has palletised storing capability and is equipped with Material Handling keeping in mind the hygiene norms to minimise human intervention. In addition to ensuring superior food quality, this model cold chain facility is also the most cost effective and energy efficient solution in the market catering to some of India's renowned and established companies in the food retail, processed food and frozen food market like HUL, Nestle, Mother Dairy etc.

minimise the moisture load of the evaporators in the chambers. Positions of the pallets in the high rise (14 meters) chambers are computer controlled. Special forklift trucks with position monitoring fetch and lift the pallets as requested.



Effective logistics

The cold storage solution has the capacity to store 7,200 Euro-pallets in five chambers for cold and frozen storage, with a total volume of 26,340 m³. Three of the five rooms are designed to operate at different temperatures between -25 °C and +20 °C throughout the year. Two rooms are flexible within the freezing range and most of the time, will be used to store ice-cream at -25 °C or seasonal products, such as white buttercream, at -21 °C. A 1500 m³ docking station with six insulated, electric operated shutters can handle up to 200 pallets per day. The docking area is kept at +10 °C in winter and at +25 °C in summer to

Expected 15 to 25% energy savings

Geographically, the company is perfectly situated in NH1, Main GT Road HSIIDC, Industrial Estate, Kundli (Sonipat) for covering the market of Delhi NCR and Northern India. The operation is in a starting phase and is working at 50 to 60% of maximum capacity.

Director of Sabharwal Food Industries Pvt. Ltd., Anil K Sabharwal, is satisfied with the cold storage solution: "We have been a Danfoss customer since 1996, and the cold storage solution is a result of the products and people behind them. Danfoss has offered and installed their best in class controls, valves, VFDs (Variable Frequency Drives) and system managers. We expect 15-25% energy savings but being a new project and not operating at full capacity, we expect to know the detailed results over the next six to nine months."

Food safety is number one priority

Growing demand for improved food quality, freshness, better hygiene standards, temperature controlled delivery, and year-round availability is crucial for Sabharwal Food Industries Pvt. Ltd. The new cold storage model is compliant with FSSAI/ food safety norms and is ISO certified.

Six vehicles can be docked at a time at the entries to the cold storage chambers. The delivery from the vehicle to the storage rooms goes through a sealed process where the entire area is temperature controlled to avoid food loss.

The entry is swipe card controlled to minimise human contact with the food products. Also, tracking and traceability is important for Sabharwal Food Industries Pvt. Ltd. Each pallet and cold room rack has a location number to ensure traceability of the food products in the cold storage chambers. The temperature can be individually set per chamber and is monitored/stored in the data system.

Danfoss expects the new cold storage model to become the best practice across India. It will also serve as a showroom for customers, who are interested in seeing how they can save energy, reduce costs, and increase food safety and run a profitable company.

Control technology

Optimum flexibility is achieved by creating two independently working refrigeration plants. One is built as a two-stage NH₃ pump circulation system, based on two Mycom screw compressors and two Vilter piston compressors. The two piston compressors can also act as a separate single stage NH₃ pump circulation system. Three cold rooms can be connected to either the low or the high temperature part of this system. In this way, the best matching evaporating temperature for the goods can be used. Combined with a remote temperature adjustment, the storage conditions of the goods are kept at an optimal level for minimum weight loss. Each room is monitored and visualised on a full-screen Danfoss System Manager enabling smart optimisation.



Energy efficiency optimisation

Energy consumption for cold stores is highly influenced by the design criteria of the refrigerating system. Studies in Europe revealed that 60 to 70% of the total consumed electricity in cold stores is used for the refrigeration plant. For modern buildings, like that of Sabharwal Food Industries Pvt. Ltd., efficient industrial illumination will change this to 80 to 90% of the total energy consumption.

The same study showed that there is a huge difference in the kWh/m³/year consumption between the cold stores. Taking out the extremes the variation is still 1 to 5. For freezing application it varies from 27 to 135 kWh/m³/year if the top and bottom 10% are removed. Climate conditions and loading pattern are partly responsible for these differences. System design and maintenance create the largest difference. Anil K Sabharwal decided for the best practice in order to achieve the lowest possible kWh/ m³/year for his plant.

3 to 5% better overall heat transfer

On the technical side, optimisation is achieved on different levels. First of all, there is the modulating control of the compressor capacity by

means of Danfoss FC103 frequency converters. Adjusting the compressor speed results in the highest possible suction pressure, and combined with the reduced electricity consumption of the compressors, the efficiency result is optimal. Also, the modulating control of the liquid level in the receivers supports the stable operation of the compressors.

The level is measured by the guided radar-based technology Danfoss Liquid Level Sensor (AKS4100) sending its 4-20 mA signal to the ICM motor-controlled injection valve. Another aspect is the ice-removal from the coolers. This is done by the efficient hot gas defrost method, using the energy in the refrigerant to heat the cooler and melt the ice. A zero-pressure drop 2-step solenoid valve (ICLX Flexline) in the wet return line of the coolers is of high impact, especially in freezing mode, as it creates the highest possible suction pressure in the liquid receivers and thereby, the best system efficiency. It is also interesting to note the choice of aluminium tubes for the air coolers. Compared to the standard steel or stainless steel tubes, these air coolers are expected to achieve 3-5%



better overall heat transfer, again resulting in a higher evaporating pressure and thereby higher system efficiency.

Internal and external safety

The well-being of the workers and the environment has a high priority for Anil K Sabharwal. In practice, this means no uncontrolled refrigerant emissions. For that reason, it was clear that wherever possible, welded connections should be used to couple the piping to all kind of valves and similar components.

All Danfoss Flexline products fit this requirement and on top of that, the relative high maximum working pressure and the PED certification of these components does give an extra safety assurance. In this respect, stop valves appear to be simple products, but the reliability of their packing glands is an important issue. Leakage should not occur, not even after many operations. Pressure shocks in a refrigeration system will cause great harm, internally for certain and sometimes externally. Smooth operation of control valves and solenoid valves will prevent these kinds of shocks. The 2-step solenoid valve (ICLX Flexline) in the wet return line of each cooler is a good example of how to avoid pressure shocks after the defrost period. In the first step, this valve opens just a bit and relieves the pressure from the cooler to the central suction.

When the pressure in the cooler is low enough to be safe, the valve opens fully. External safety is also embedded in the relief valves mounted on all pressure vessels. Danfoss safety relief valve (SFA) is known for its reliable opening at set pressure and for the closing function if the

pressure has been reduced to 10% below the set pressure. This minimises the emissions in case the pressure becomes too high.

Personal safety is secured by the availability of gas masks and fresh-air line masks in case corrective action must be taken after an ammonia leak. Walking tracks and safety lines are part of the emergency system in every cooling room. Frequent safety meetings with all employees keep the focus on possible dangerous situations. Of course, a fire alarm is part of the system, as well as an emergency assembly point and a wind sock to be able to gather up wind in case of an ammonia leak.

Cost of ownership

The initial investment in the new cold store is 250 million INR. The return on this investment should come via a trouble-free operation, combined with a high volume of pallets. Often ignored in an industrial cold store is the risk of extra costs in connection with accidents and component failure. Most of the time, the cost of the repair is much less compared to that of loss of production or even loss of goods. For the owner of a cold store, complex preventive maintenance will be an investment of which it can never be proven that it pays back. Only after a breakdown of the plant, without maintenance, the cost balance can be calculated. But who wants to wait for that? Anil K Sabharwal invested in a petrol driven power generator to take over during electrical power outages. Only in this way he can assure the high quality of the stored goods. For each compressor, there is a spare available for immediate replacement if something should happen. The Danfoss controls have a proven record of extremely solid performance and, with a good maintenance schedule, they will maintain this for several decades. On top of that, the new Flexline products have the important benefit of the "parts program" principle. The welded house will

stay in the pipe system and the operational insert can be replaced as complete unit, enabling a safe, quick and reliable transition to a complete, fully operational, new valve. The off-period for the plant is kept to an absolute minimum in this way.

For standard preventive maintenance, Danfoss delivers dedicated repair kits for a professional service job. A clear proof of good investment is the application of the Flexline valve station (ICF) for liquid supply to the coolers. All essential components are mounted in the same house with stop valves on the inlet and outlet. The internal volume of the valve station (ICF) is extremely small, and in case a filter has to be cleaned, it takes ample time to remove the refrigerant and to start the cleaning job. Maintenance personnel tend to clean more often when that job is easier. A clean system is a more efficient system, so it pays back from two sides.

Summary

The above description reveals some of the important drivers of an efficient cold storage model, initiated by Sabharwal Food Industries Pvt. Ltd. in India. Most of the drivers are the result of common sense, down-to-earth thinking. The strength in this solution is the combination that makes all drivers move in the same direction of an efficient and profitable operation.

About the company

Sabharwal Food Industries Pvt. Ltd. is an ISO 22000:2005 certified company offering cold storage and storage of bread, baked goods, and processed foods. The company has a dedicated workforce of 300 people. This company provides solid and cost-effective farm-to-consumer solutions. It has strong relationships with their customers – some of the most respected food companies in India and worldwide. ■

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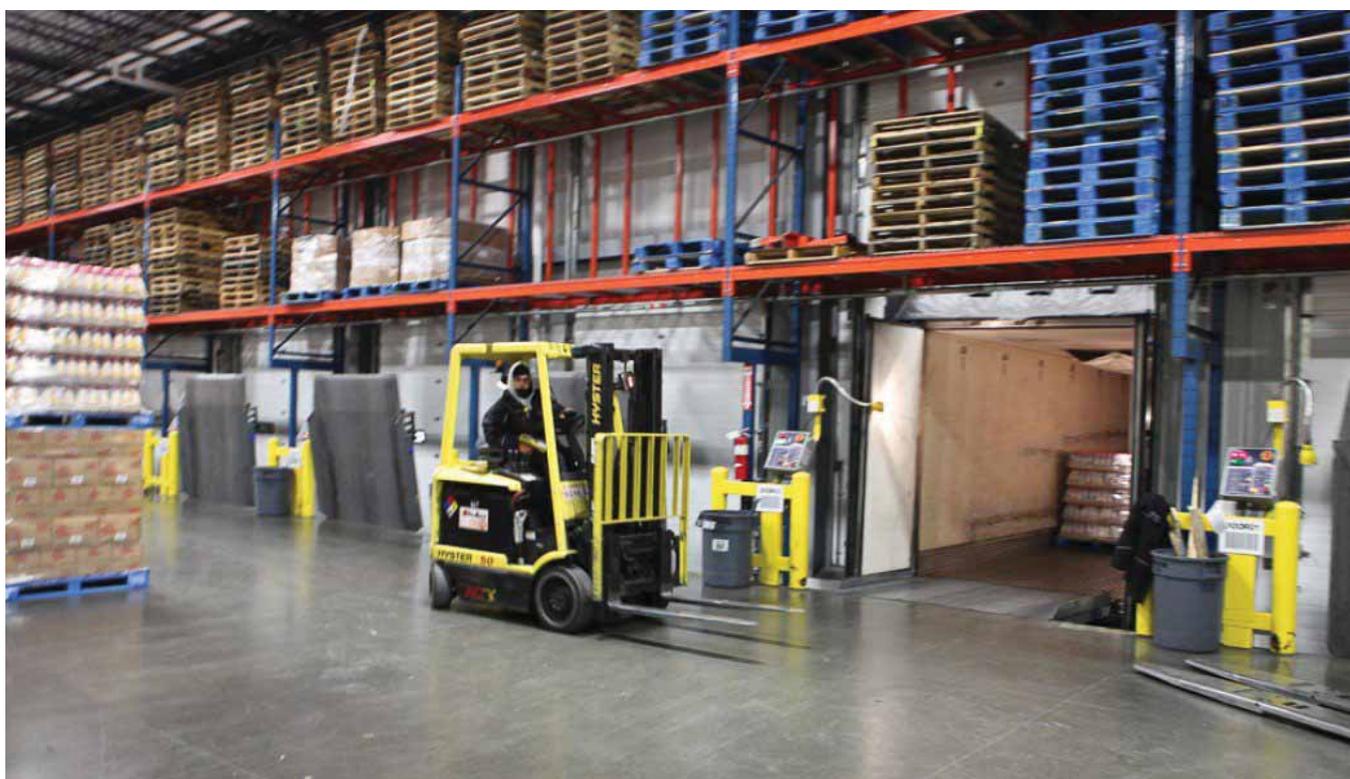
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Indian Cold Chain

– An Emerging Industry

Contrary to the popular belief, cold chain is not merely refrigeration of perishable commodities. Cold chain is a logistics system that provides a series of facilities to maintain ideal storage conditions for perishables from the point of origin to the point of consumption in the food supply chain...



India is one of the world's largest consumers of food and the third largest producer of agriculture, according to 2015 Top Markets Report on Cold Chain by International Trade Administration. India also holds the distinction of being the largest producer of milk in the world and boasts of having the largest livestock population. Food processing refers to value addition to agricultural or horticultural produce. The food processing sector comprises two segments- Primary (packaged fruits and vegetables, milk, etc., constituting around 62% in value) and Value added (processed fruits and vegetables, juices, jam & jelly etc constituting around 38% share in the total processed food).

According to Indian Brand Equity Foundation (IBEF), the food processing industry accounts for 32% of India's total food industry and 13% of Indian exports. The industry ranks fifth in terms of exports, production and consumption. Whereas the food processing industry

looks promising for India, however, it must be considered that the local markets or farmers often have to rely on inefficient supply chain or middlemen. The farmers, at times, do not have the requisite infrastructure, technical know-how or capital investment to channelize into cold storage and supply chain development.

Add to that, the fragmented infrastructure of cold warehouses, transportation and associated services. This is a major reason why we require integrated logistical support, and in particular, cold chain solutions to enable easy accessibility and smooth flow of produce from farms to table, fresh and safe. It would also enable farmers to extend the life cycle of perishable products, traverse long distances, reach wider market segments and larger consumer base.

Around 40% of our produce is wasted due to inadequate cold chain infrastructure, and one third of losses incur during storage and transit

leading experts to opine that India has less than half the capacity to meet its current cold chain needs.

Phenomenal growth

Growth rising Indian population, mounting consumer incomes and changing preferences have led to increased focus on food security and health services. The demand for processed food has also risen sharply necessitating the support from efficient cold chain logistics of the country. Often termed as the sunrise sector, cold chain logistics hold immense growth potential in India and there is a great need to respond to the high growth opportunities in the cold chain logistics sector, which identifies cold chain sector as a promising & lucrative investment option.

Industries like organized food retail and QSR (Quick Service Restaurants) owe much of their growth to the cold chain sector. An effective cold chain infrastructure forms the very backbone of the food industry in India. In the view of rising population and appalling healthcare status, **ensuring food security to every Indian and easy availability of medicines** has scored as a top priority in government agenda. The sector has effervescent future with the much revered government backing, apparent growth in user industries and favorable demographics of the country. Indian market is evolving with changing lifestyles, rising urbanization and growing disposable incomes which will be the key benefactors of growth in cold chain user industries like food service industry, processed food industry and organized retail industry. Additionally, mounting government endeavours towards reducing food wastage and penetrating healthcare in deep corners of the country will help in strengthening cold chain infrastructure in India. The cold chain sector in India is still in the nascent stage with enormous growth potential on the back of climatic diversification and geographically vast size of the country. Indian cold chain sector was estimated to be at INR 245 billion in 2013, and it was anticipated to cross INR 600 billion mark in the next 4 years.

Present status and future prospects

Temperature-controlled storage and distribution in supply chain management or cold chain management has two main segments, namely, refrigerated transport and surface storage. Whereas the former uses refrigerated trucks, containers and cars for transport of perishable products, the latter comprises temperature-controlled warehouses for storage. Both the segments require technical and quality standards to ensure longer shelf life and selling value of products – and are important for the growth of cold chain management solutions.

Cold chain involves the transportation of temperature-sensitive products along a supply chain through thermal and refrigerated packaging methods to protect the integrity of these shipments. There are several means in which cold chain products can be transported: Refrigerated trucks and railcars; Refrigerated cargo ships; and Air cargo. India's cold chain sector is a combination of surface storage and refrigerated transport. The industry has been growing at a CAGR of 20% for the last three years. Cold stores are the major revenue contributors of the Indian cold chain industry.

India has seen a dramatic increase in the production of perishable products including fruits, vegetables, meat, poultry and dairy. It ranks first in global milk production with an annual rate of 138 million tons – and hosts more than 50% of milk product processing. With vegetable production of 280.4 million tons, it ranks second globally and only hosts 6% of total processing.

There has also been steady growth in the fish and meat industries due to export potential. Current cold storage capacity in India totals 31.8 million tons. Growth has averaged 3 to 4% over the past 10 years, and 10.5 mil-

lion tons of space was created in the last seven years. Ownership is mainly in the private sector, with the public and cooperative sectors only comprising 10% of capacity. The sector's value is estimated at \$6.5 billion (USD) and market growth has averaged between 15 to 20%. This pace is expected to be consistent over the next five years.

Currently, India has 6,300 cold storage facilities unevenly spread across the country, with an installed capacity of 30.11 million metric ton. These are mostly used for storing potatoes. However, the market is gradually getting organized and focus towards multi-purpose cold storages is rising. More than 50% of the cold storage facilities in India are currently concentrated in Uttar Pradesh and West Bengal, while other states still face a challenge with investments from the government and private operators. Some facts about Indian cold chain industry:

- Organized players contribute only ~8 to 10% of the cold chain industry market
- 36% of these cold storages in India have capacity below 1,000 MT
- 65% of India's cold chain storage capacity is contributed by the states of Uttar Pradesh and West Bengal
- At the current capacity only less than 11% of what is produced can be stored.



Government initiatives

India is one of the largest producers of agricultural products and one of the global leaders in the pharmaceutical sector. Yet, it is known to have a fledgling cold chain, which results in supply chain losses of food and other resources. These losses have been stated to be as high as US\$8 to 15 billion per annum from the agriculture sector alone. To address this concern, the government had earlier constituted a National Task Force on Cold Chain in 2008. The agriculture and food processing sectors in India have been developing and today India is a net exporter of food grains.

This is a dramatic transformation from the 70s and 80s when India used to import food grains to feed its population. This has largely been a result of the higher yields achieved as a result of the Green Revolution. Alongside this, there have been significant strides in the production of fruits and vegetables. However, lack of proper and adequate food storage, processing and cold chain logistics remains a serious challenge. The Government of India is one of the driving forces in developing the cold chain industry and supports private participation through various subsidy schemes and grants. Investment in cold chain in India was also opened under the automatic route for 100% FDI participation. The

existing cold chain in India largely comprised comparatively small private companies with a regional or local footprint.

During last 2 decades, India has been developing at a fast pace and an increasing demand for high value foods with a shift towards horticultural crops has been documented. This, with rapid urbanization, resulted in multi-fold changes to the spending and consumption pattern of India's population. The existing food supply chains were unable to cope with these fast changing demographic trends and the lack of efficient and effective supply chains is understood to lead to a variety of losses in the perishable food segment.

In 2012, Indian farmers produced 240 million metric ton of horticultural produce, almost equal to its grain and cereals production. Various studies indicate that 18 to 40% of this produce was lost due to supply chain inefficiencies, concluding that a focused effort was required to promote the development of the cold chain in the country. The Indian government and its Planning Commission spelt out clear intention that cold chain has to be supported. Amongst the core identified development areas are the base infrastructure, environmentally-friendly technologies, standards and protocols, enabling policies and specialized skills. The Indian government is taking steps to improve the cold chain infrastructure,



by recognizing the cold chain industry as a sub-sector of infrastructure in the previous Union Budget and creating an additional Budget to construct new cold storage facilities.

The private sector is being encouraged to develop the cold chain industry further by implementing the latest and most effective refrigeration technology solutions available today. For private players the high level of initial capital required to construct a cold chain unit continues to be the biggest challenge. But if the government pitches in with a clear plan and promotes more PPP initiatives in this field, we could see a momentum growth in the cold chain industry in India. Initiatives to boost the cold chain infrastructure:

- 100% FDI through government route
- Since 2011-12 cold chain has been given infrastructure status
- Viability gap funding up to 40% of the cost
- 5% concession on import duty, service tax exemption, excise duty exemption on several items
- Subsidy of over 25 to 33.3% on the cold storage project cost
- Establishment of National Centre for Cold Chain Development
- Proposed financial outlay for cold chain infrastructure & food parks of US\$335 million and US\$650 million respectively
- Over 50 to 70% capital grant on projects.

Towards a modern cold chain

A modern cold chain uses climate control technology and modern packaging and handling, from the time of harvest of the produce to the

point of sale. In such a supply chain, the produce is maintained in a controlled climate environment from the stage of harvest till the point of purchase (read retail stores).

The controlled climate environment reduces the rate of metabolism in harvested Fruits & Vegetables, hence extending the shelf life of the produce. Whilst the degree of life extension due to controlled environment varies from one fruit/vegetable to another, the impact is significant across. Any break in the environment across the chain accelerates the rate of decay. Thus, modern cold chains are designed to start right from the farms. The produce is pre-cooled within an hour of harvest to suck out the farm heat from the produce and retard decay. Transportation is in reefer trucks, storage is in controlled climate warehouses, and retailing is through refrigerated shelves. Such a supply chain not only reduces value loss and damages across the chain it also enhances the life of the produce. Life extension allows the stakeholders a couple of significant arbitrage opportunities – temporal arbitrage and geographic arbitrage. Temporal arbitrage is the buying of the produce when the prices are low, and selling when the prices are high. Geographic arbitrage, however, is buying the produce where the prices are low and selling where the prices are high. With short shelf lives, both the opportunities cannot be tapped - however life extension opens windows to these opportunities.

With a large number of global food and retail chains targeting the India markets, FDI in retail is just around the corner and is likely to be implemented soon. Then government is also promoting the food safety and security bill that would further demand storage and cold chain facilities in order to reduce the amount of food wastage.

With the expected future development in road and rail infrastructure, along with the changing lifestyle of the Indian consumer – Indian cold chain industry is expected to grow at a CAGR of 28% over the next three years and reach a market size of \$13 billion in

2017, although it is largely unorganized in nature. Thereby, presenting a great opportunity for foreign players. But for this to happen, the government will have to play a very important catalyst role.

Globally cold chains have now become an integral part of supply chain management for the storage and transportation of temperature-sensitive goods. The focus has now shifted from increasing production to better cold storages and transportation of food produce. The utilization of cold chain logistics includes both cold storages and refrigerated transportation and is used to increase the shelf life of food produce. With 35 to 40% of agricultural produce in India being wasted due to lack of proper cold storage facilities, it is immensely important that a focused effort is required on part of the government to encourage the use of cold chain among market participants. Some of the likely steps that the government could take are mentioned below:

- Provide requisite support like lower cost of funding for setting up cold chain infrastructure facilities.
- Promote awareness campaign and educate market participant about the importance of cold chain facilities.
- State governments can encourage setting up of cold storage facilities by providing subsidized power tariff as power forms a significant proportion of the operating cost.
- Encourage better and more efficient refrigeration technologies to improve the shelf life of perishable products.

Key challenges

Lack of quality cold warehousing infrastructure: There is a severe shortage of cold chain warehousing capacity as only 25% of the capacity is available for fruits, vegetables, processed foods and pharmaceuticals, whereas 75% of the capacity is dedicated to potatoes.

Lack of standards and protocols in construction and operation of facilities: Technical standards followed in India are mostly unsuitable for Indian conditions, which results in lower performance of standard refrigerated systems.

Low awareness of labour in handling temperature-sensitive products: In India, the supply chain of most products is long and fragmented. A product changes many hands from source to delivery point. Most workers involved in this are not properly trained in handling temperature-sensitive products resulting in deterioration of product quality before reaching the consumer.

High fuel cost and power cuts: Fuel costs in India constitute around 30% of operating expenses of cold storage in India as compared to 10% in the West. Further, cold storages are dependent on steady supply of power. Most Indian regions face power cuts. Hence, these companies have to invest in power back-ups, which push up the capital investment requirement.

Conclusion

Cold chain which is supposed to be the fulcrum of an effective supply chain infrastructure in dealing with fruits and vegetables remains a grossly ignored area in India. What could have turned out to be a huge asset for national economy keeps on lingering as a serious weak spot. We not only have issue with Cold Storage, other functional modalities such as facilitating seamless movement of goods via refrigerated

vehicles which has done wonders in countries like China is presently best considered to be a farfetched idea in the country.

Cold Chain Management deals with efficient control and organization of production and logistic regarding temperature. It comprises planning and implementation of single processes and process steps as well as implementation of instruments and methods of process monitoring and control. The principal aims of Cold Chain Management are optimization of product quality and product safety and minimization of wastage.

In a practical way cold chain management often means temperature monitoring at each step within the production, storage and transportation chain on inner- and inter-operation levels.

Contrary to the popular belief, cold chain is not merely refrigeration of perishable commodities. Cold chain is a logistics system that provides a series of facilities to maintain ideal storage conditions for perishables from the point of origin to the point of consumption in the food supply chain. The chain needs to start at the farm level – post harvest, pre-cooling, etc. – and reaches to the consumer or at least to the retail outlets. A well organized and efficient cold chain reduces spoilage, retains the quality of the harvested products and guarantees a cost efficient delivery to the consumer. A significant aspect of the system is that if any of the links is missing or weak, the whole system might fail. ■

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Environmental Health

& Safety In Cold Room

A number of health and safety problems can occur in cold rooms. These problems range from inhalation exposure of mold, unsafe use/storage of chemicals resulting in inhalation exposures, and storage of food and drinks in cold rooms resulting in potential ingestion exposures to molds. This article reflects good laboratory practices that users of cold rooms are expected to follow...



Intention of Cold Rooms

The intention of cold rooms is to properly store certain agents and to conduct certain tests at a controlled temperature. Storing cellulose containing items can promote mold growth. Since biological and chemical agents are found in cold rooms, the potential for cross contamination of food and beverages can occur. To that extent, these guidelines are recommended to minimise mold growth, recommend correct chemical and biological use and storage, and list some activities that are prohibited.

EHS is quite valuable in each and every field, in the past, cold rooms for labs consisted of insulated boxes that did NOT have any ventilation. Some of the newer cold rooms were provided with a small volume of fresh air to help ventilate the rooms. The supplied air was intended to prevent the build-up of carbon dioxide generated from personnel in the room as well as other contaminants that might be released in the room. Unfortunately, this small volume of supplied air created moisture problems contributing to mold growth, especially when trace contaminants are present on surfaces. The result creates potential mold inhalation exposures for personnel. Because cold rooms do not have ventilation systems, occupancy of cold rooms is limited to a total of two hours per 24 hour period.

A number of health and safety problems can occur in cold rooms. These problems range from inhalation exposure of mold, unsafe use/storage of chemicals resulting in inhalation exposures, and storage of food and drinks in cold rooms resulting in potential ingestion exposures to molds. This article reflects good laboratory practices that users of cold rooms are expected to follow.

Personnel can experience inhalation exposures to mold and a build-up of carbon dioxide when they are in cold rooms. EH&S's Occupational Safety Unit (OSU) has tested the build-up of carbon dioxide in a cold room and determined that the OSHA Permissible Exposure Limit (PEL) for carbon dioxide of 5000 ppm is achieved when 4 individuals occupy a cold room continuously for a period of about 55 minutes. Although the OSHA PEL is for periods of 8-hours, OSU recommends personnel can occupy a cold room safely, based on the carbon dioxide level, for a period of 2 people-hours per day, to provide for variations in the size of the cold rooms.

GUIDELINES

Minimizing Potential Mold Growth

Mold has been found in many cold rooms. Every surface in a cold room can become contaminated with mold quickly should an improper work practice occur. The result is potential health problems from inhalation of the mold spores as well as contamination of research materials.

The storage of cellulose containing materials is a leading cause of mold growth. Mold growth can contribute to contamination of research materials. Preventing mold growth in cold rooms is achieved by controlling condensation/moisture and removing materials contributing to mold growth. The following actions need to be followed:

- Promptly clean up spilled liquids (e.g., buffers, media). Mold can thrive on any organic medium.
- Report water leaks if any.
- Keep door firmly shut to prevent condensation. Doors left open can increase the relative humidity in the rooms and promote mold growth. Placing a Relative Humidity (RH) gauge in the cold room and maintaining the RH at less than 60% helps to discourage mold growth.
- Damaged door gaskets can provide a cold surface resulting in condensation problems. Watch for condensation on other surfaces as well. Condensation may be an indication of a loss of containment.
- Remove all wood. Wood shelves can absorb moisture and, because it is composed of cellulose, is a perfect breeding ground for mold. Wood shelves need to be replaced with open stainless steel shelves that permit air flow throughout the storage area.
- Remove all cardboard and paper products. These surfaces act just like wood and promote mold growth. If some paper products (e.g., Kimwipes) are required, place them in a closed plastic container between uses. Should visible mold be found on a paper product, discard the item immediately.
- Keep surfaces clean. Never use bleach on metal surfaces (bleach on metal surfaces can result in pitting). Wet cleanup activities are recommended (sweeping, dusting, or brushing will release mold into the air and can cause inhalation exposures and spread potential contamination).
 - If minor cleaning is needed, use a wet clean up method (e.g., dampen cloth with a non-ammoniated soap or detergent (do not mix ammonia and bleach: the fumes are toxic). Dry surfaces after cleaning to ensure moisture has been removed.
 - If mold reappears soon after cleaning, use any hospital approved disinfectant, drying surfaces after cleaning to ensure moisture has been removed.
- Place a label on the cold room door to remind users not to store paper/wood materials in the cold room as well as clean up small spills of materials soon after they happen.
- Users will be held responsible for cleaning mold growth if EH&S inspections note improper actions that could contribute to mold growth.

Proper Chemical Use and Storage

Cold rooms are designed to recirculate the air contained within. Chemicals vapourizing into the air can accumulate and pose an inhalation exposure or an explosion hazard to personnel. Therefore:

- Many flammable solvents can release sufficient vapours to form explosive atmospheres. These rooms have fans and electrical laboratory equipment that are potential ignition sources. Large quantities (>1 liter) of flammable solvents must NOT be stored in cold rooms. On a related issue, a standard refrigerator must never be used for the storage of flammable materials. Rather, flammable storage refrigerators need to be used.
- Since cold rooms have a contained atmosphere, some hazardous chemicals that are not flammable may vapourise (e.g., chloroform, formaldehyde) causing exposures to personnel. The lab staff must consider this risk when evaluating the safety of their procedures and perform those procedures where vapours are released in a chemical fume hood. Quantities need to be limited to less than 250 ml (note: chemicals such as chloroform vaporize very quickly. Such chemicals should NOT be placed in squeeze dispenser bottles.
- Spills of organic chemicals can occur in cold rooms. Prompt removal of the spilled materials is essential.

PROHIBITED ACTIVITIES

To ensure the safety of employees the following activities are prohibited in cold rooms:

- Beverage storage: In the past, EH&S has found alcoholic and non-alcoholic beverages stored in cold rooms. Such storage is unacceptable. Should EH&S note such storage, the issue will be reported to Security for immediate removal.
- Food storage: Many food items can absorb chemical vapours that may be released into a cold room. To prevent the ingestion of possibly contaminated foods stored in this manner, personnel will be informed of the problem by EH&S with the expectation that the food will be removed immediately.
- Compressed gas usage: Gases released from incubators and other devices in a cold room can result in a lowering of the oxygen level, resulting in possible asphyxiation. Gases should be used outside of a cold room. In the event gases must be used in a cold room, an oxygen sensor, equipped with a local alarm, must be installed in the cold room to warn staff should a low oxygen level occurs.
- Never store dry ice in a walk in cooler. Dry ice can create an oxygen deficient atmosphere when it sublimates and releases gaseous carbon dioxide. ■

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M.E Cryogenic L. D.
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Ahmedabad





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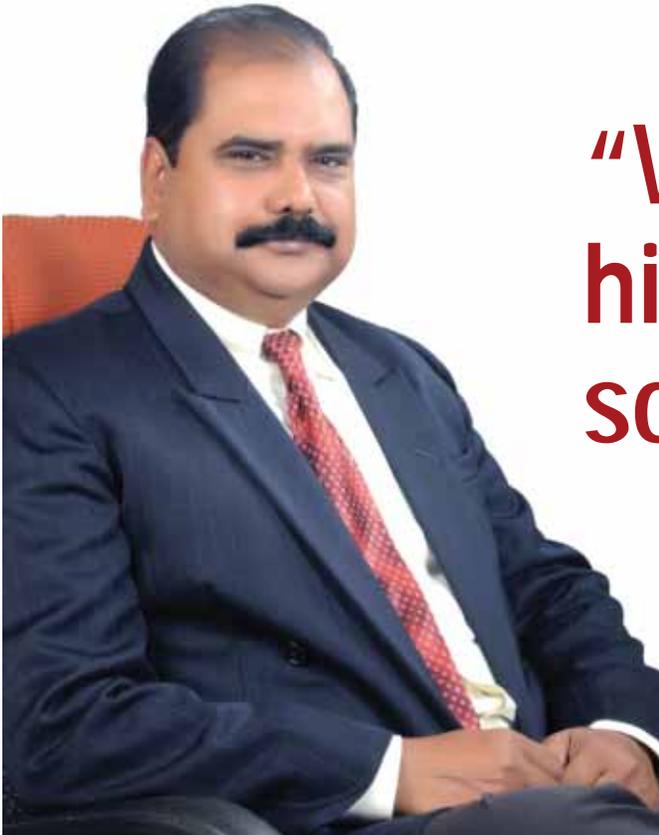
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“We sell the high efficiency solutions...”

With more than 6000 products in its kitty, **CAREL ACR Systems Pvt. Ltd.**, a subsidiary of **Carel s.p.a. Itlay**, has been serving the Indian HVAC&R industry since 2008. In an e-interview with **Cooling India**, **Sanjog Belatikar, Senior Manager – Sales, Technical Department**, of the company is describing their business activities and strategies to **PK Chatterjee**. Excerpts...

How has CAREL's business shaped up in India in the last one decade?

Carel s.p.a. Itlay, opened up the Indian subsidiary in the year 2008, and since then it is growing in double digits every year. At Carel, we do not sell the products but we sell the high efficiency solutions, which consists of the package of various products that can be complete solution for any need of HVAC&R industry.

The entire market is classified in four major segments such as HVAC OEMs, HVAC Projects, Refrigeration OEMs and Refrigeration projects. Our list of esteemed customers includes all the major players in HVAC&R industry – such as Blue Star, Kirloskar, Voltas, Carrier to name a few of them. It is expanding as there are additions every year.

What are the major areas (component-wise) where you are catering to?

Carel has more than 6000 products in its kitty, which includes programmable controllers, parametric controllers, electronic expansion valves, sensors and humidifiers etc. The maximum revenue comes from PCO controller (programmable controller-PLC), which is used mainly in screw/ scroll chillers, PACs and CCUs. This is followed by another popular product – Parametric controllers, which are mainly used in Panel A/Cs, Air driers, Deep freezers, bottle coolers etc. The next major sales comes from the humidifiers – which is mainly used in HVAC projects. Carel has wide range of humidifiers in both types, Isothermal (steam) type as well as Adiabatic (mist) type. These are used in various applications such as Pharmaceuticals, textile, cold storages, automobiles etc.

How does CAREL help companies to build a sustainable cooling environment?

CAREL has always developed and promoted evolved control systems, proposing innovative solutions in the HVAC&R sector. These are our 'high efficiency solutions,' a clear response for environmental protection through optimised and integrated control systems, capable of bringing significant energy savings and consequently reducing environmental impact.

These are new solutions for the market, yet the choices made are still in line with our tradition: we have always invested in R&D, right since we first started business, and we continued to do so despite the global recession.

These cutting-edge control solutions are now available, and their full potential is ready to be exploited, to achieve an effective competitive advantage on the world scene and be rewarded by the market.

Using CAREL 'high efficiency solutions' today means doing something concrete to contribute to protecting the environment. It means looking to the future with confidence.

What are the primary areas of an HVAC&R system that need to be taken care of to reduce energy consumption and pollution?

As I told you earlier, Carel believes in selling the high efficiency solutions and not just the particular product. The main focus area of Carel products is towards reducing the wastage of energy by optimising its usage. The products – like electronic expansion valves – can reduce the energy consumption by 20 to 30% over the

conventional Thermostatic valves. The Chill booster product, which is basically designed for the air cooled chiller, can increase the efficiency of the chiller especially in peak summer.

The PCO controllers used for chiller management optimizes the working of the chiller when they are working in tandem.

The high pressure humidification systems can also be used effectively for the evaporative cooling application such as ware house cooling, shop floors cooling, wedding halls cooling etc.

This system consumes very less almost negligible energy as compared to mechanical cooling.

What kind of new technologies are you bringing to India?

Carel spends heavily on research and development to get new efficient products and systems. Indeed our mission states that we invest in innovation with the objective of ensuring increasing energy savings. The company invests significant sums in Research & Development every year, totalling 10% of consolidated sales. Of this amount, 7% goes into Research & Development and a further 3% is regularly invested in production technology, so as to assure improvements and continuous development. Some of the innovative solutions, which have been introduced in India are as follows:

- a. power+ is a special inverter that can control compressors with permanent magnet brushless motors (BLDC/BLAC) Integrated into pCOsistema+, it brings significant energy savings by modulating compressor speed and consequently the cooling capacity of the unit. Variations in load are managed precisely and with constant control of the compressor envelope. This makes significant increases in unit COP possible during operation at part load, giving higher Seasonal Performance Factor values (SPF).
- b. C.pco Mini Controllers: Developed a comprehensive platform for the management of the most advanced units available in the market, featuring:
EC fans for precise regulation of the air flow;
Integrated refrigerant circuit, in particular with BLDC compressors, to maximize energy recovery from the exhaust air;
high efficiency CAREL devices for maximum energy savings: power+ inverters, EEVs, adiabatic humidifiers.
- c. Evaporative cooling solutions: Adiabatic humidifiers feature very low power consumption, as the only energy required goes into atomising the water. Several different technologies are available, however evaporative cooling systems are generally green, energy-saving solutions.
Adiabatic humidification can essentially be used in three situations: direct evaporative cooling, indirect evaporative cooling and for chillers and dry coolers.
- d. HEOS BLDC technology: guarantees higher energy efficiency compared to any other available technology, with a very wide range of cooling capacity modulation. Excellent operation at part loads moreover guarantees maximum efficiency in terms of performance and COP, in all situations. Serial connection to showcases fitted with MPXPRO controllers: the operating conditions of each showcase are sent to the condensing unit in real time, allowing advanced control algorithms to be implemented so as to further increase energy efficiency.

Carel spends heavily on R&D to get new, efficient products and systems. Its mission states to invest in innovation with the objective of ensuring increasing energy savings...

What is the role of software in the efficient management of HVAC&R system?

The software has major role in the efficient management of HVAC &R System. Carel controllers which are supposed to be the main brain of any air conditioning equipment must have very intelligent and proven software which has been developed for the particular application. Our more than 40 years of experience and continuous focused research on amalgamation of thermodynamics and electronics has given the competitive advantage over the other controller manufacturers. The global presence of Carel has widened our knowledge bank – which has helped in providing solutions for any type of geographical conditions.

What is CAREL's contribution in this area?

Carel has recently introduced the new software development tool called C-Suite, which is very user friendly and can be used by the end user with minimal initial training.

Could you please cite one or two examples (in brief) on how your assistance has helped Indian companies in achieving their sustainability goals?

Precision Air conditioning units (CCU): Almost all precision air conditioning units manufacturers – such as Schneider Electric, Stulz India, Swegon blue box etc. – use Carel products in their machines. In this field, where continuity of operation (Mission Critical) is essential, the ongoing technological development and research on energy savings are reflected in a constant evolution of air conditioning solutions. Thanks to its 40 years of experience in this field and to the continuous research, Carel provides integrated solutions for temperature and humidity control, based on an extensive offer of innovative, reliable and energy saving products: programmable electronic controls, sensors, humidifiers, evaporative coolers, electronic expansion valves, BLDC inverters and monitoring systems.

What are your short-term (say next three-years) plans for India?

Carel has very ambitious and definitive plans for next three years. Being one of the major providers of green solutions, Carel will be focusing on creating the awareness towards the high efficiency solutions, which may look very expensive at prima facie but definitely pays off in long term ensuring the sustainability. Carel has already made good impression in HVAC&R Industry in India and would spread the reach on Pan India basis through dealer network supported by Carel own trained engineers.

What are your suggestions (in general) to the Indian HVAC&R system managers?

In any establishment, whether it is a commercial building, a data centre or any process industry, the HVAC consumes major power. The objective of the HVAC System manager should not be only to achieve the required air conditions – but he should also think about the various ways to optimise the energy and reduce the wastage. They should try to use the new innovative products, which have been already tested and proven elsewhere. ■

Valves And Actuators

Maintaining The Foundation Of High Performance Buildings

Control valves and actuators are the unsung and unseen heroes of building management systems. They control a large amount of the 35% of energy used in a building's HVAC system. Yet they are routinely ignored when it comes to system maintenance. This article explains how control loop and valve service inspection can save time and money. Proactive, predictive valve maintenance programs are also discussed...

Building owners invest significant resources in environmental and building control systems. These systems can be costly to operate, yet essential for occupant comfort, productivity and safety. Of all the devices and systems inside a building that control the environment and manage energy use, valves and actuators are most frequently overlooked despite the fact that they form the foundation for an effective Building Management System, or BMS.

HVAC equipment including valves, actuators and sensors can account for

approximately 35% of energy use in commercial buildings.

Efficient, smart buildings manage those costs with reliable HVAC control devices that help regulate and decrease a facility's energy use. These devices provide early warning of potential problems and dangerous system conditions. Valves and actuators play an important role in HVAC control for a variety of applications; including Fan Coil Units (FCU's), Air Handling Units (AHU's), chillers, boilers, and variable air volume reheating among others. These applications are found in a wide range of

market segments; such as healthcare, data centers, commercial buildings, and education.

While these critical control devices can operate for years without a problem, when something does go wrong it often goes undetected. Valves and actuators are often not a specific focus in most service contracts, and are simply considered part of the overall BMS. Despite the importance and expense of maintaining building efficiency, most building owners/operators – some 55% in the United States – rely on reactive maintenance strategies. This means they wait until equipment, for example critical control devices, falter or fail completely before initiating corrective action. By acting only when a failure occurs, building stakeholders risk that repair costs will be at a maximum and that interruptions to service will occur while repairs are being made. This impacts not only the cost and performance of the HVAC system, but also the entire BMS.

In these instances predictive maintenance contracts have the potential to deliver significant energy savings and improved building performance and comfort. Using analytics to leverage the data generated by modern systems and devices that make up the building infrastructure network is the most efficient approach. The data provides accurate, timely and actionable information that can be leveraged to refine service programs and achieve optimal building performance and cost effectiveness. Building owners and operators are then in a position to make data driven decisions based on the impact of maintenance on building efficiency and performance.

This article discusses the nature and cost of poor valve/actuator performance, and

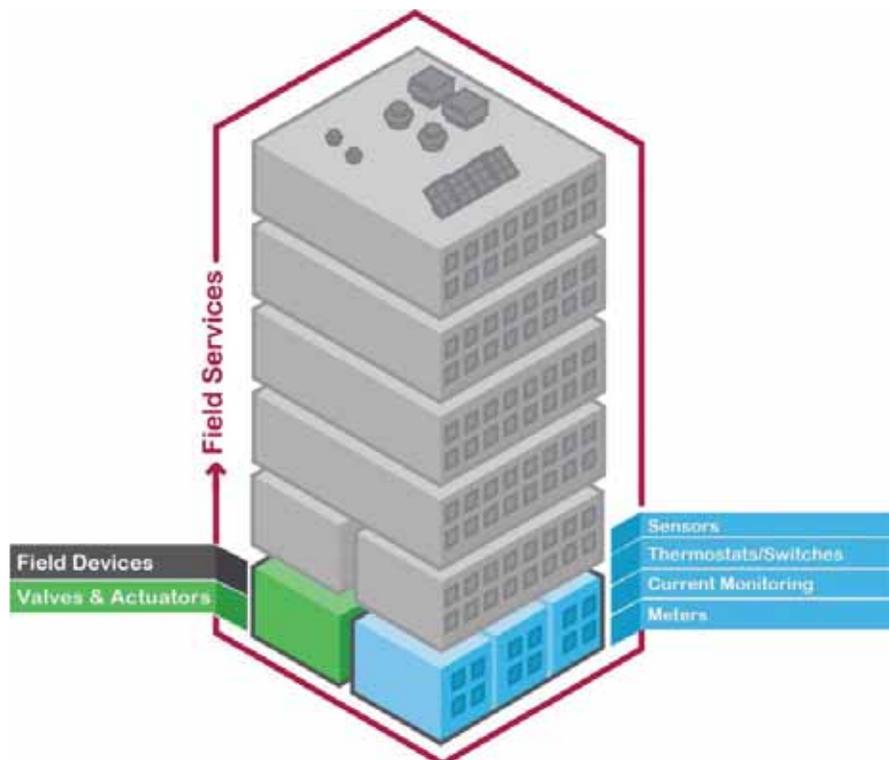


Figure 1: Valves and actuators sit at the core of a building's physical infrastructure...

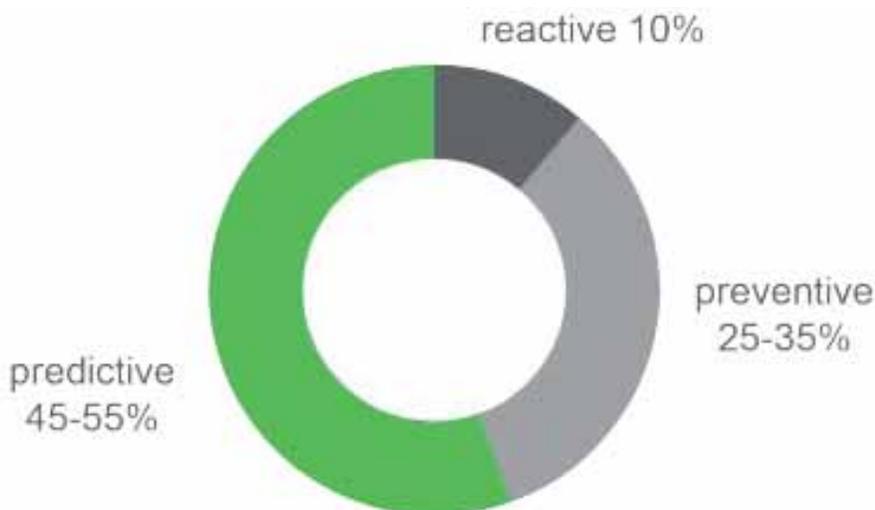


Figure 2: Types of maintenance programs used in top performing facilities...

prescribes a proactive, predictive valve maintenance approach.

The significance of valves and actuators

Valves and actuators seem like simple devices, but their sheer number can make maintenance a challenge. A large commercial facility could have thousands of valves and actuators throughout the building located in individual spaces, AHUs and the central plant. Furthermore, they perform critical functions. For example, the fluid control valve regulates the level of energy output from a heating or cooling coil, which in turn has a large impact on comfort and energy costs throughout a space or building.

Even newer buildings can experience hidden valve problems. Some typical problems include:

- Improper installation, selection or sizing
- Linkages become disconnected
- Reset activates a manual override
- Debris during the flushing cycle can foul internal workings
- Chemicals during the flushing cycle can damage seals.

Despite their importance, for most facility managers, valves are not top of mind. Most often, electrical components such as pumps and fans, where it's easy to see power usage and cost in kW/h, present a higher priority.

However, valves and actuators are often the root cause of serious problems such as poor equipment performance, unproductive maintenance calls, and unexplained rising energy use. This, in turn, leads to the following issues:

- Increased costs due to unplanned equipment downtime

- Increased labour costs, especially when overtime is needed
- Costs involved with repair or replacement of equipment
- Possible secondary equipment or process damage from equipment failure
- Inefficient use of staff resources.

HVAC systems consume about 35% of the energy in most commercial buildings with valves and actuators responsible for a significant amount of that environmental control. Bottom line: When the valves aren't healthy, the building isn't healthy.

They enable efficiency and contribute to the overall value of the BMS. If measurement of control at the field device level is not efficient, the BMS is not performing at an optimal level and services are relegated to "firefighting mode."

Common valve problems

The purpose of a building management system is to control and adjust the environmental systems to achieve a desired temperature while minimizing energy consumption. Variables such as changing occupancy, load on the building system, and seasonal changes require that valves adjust appropriately and accurately under varying conditions. Valves are constantly working and are subject to wear, as well as to damage from chemicals or debris. The damage that can occur falls into two general categories: physical problems and system problems. Either can result in wasted energy, unnecessary equipment wear, and poor occupant comfort.

Physical problems

Typical physical problems include leakage via the valve seat (internal) or valve stem (external), worn actuator linkage, and noise in

the piping system. Sometimes actuators are manually positioned (in which case its position is lost if there is no feedback or recalibration).

Other problems include:

- Damage to valve internals/seals from debris in the water, excessive chemicals, or foreign matter introduced through an open system
- A leaking or overridden valve that needs the associated opposite valve to compensate. The opposing coil consumes extra energy by compensating for the load. This is very costly especially in buildings with large cooling loads. This situation may not be detected as the desired temperature is achieved, but at the cost of greater energy consumption
- Control loop hunting, in which a heating and a cooling valve operate in a sequenced cycle from closed to 100% open. When an overshoot of the set point occurs, the control loop then reacts by closing both valves in sequence and then starts to open them to 100%, and then back to the closed position. This scenario is often associated with incorrect PID control loop parameters or seasonal performance variation and is extremely energy inefficient.

Control system problems

Control loop stability is an essential part of energy efficiency. The BMS utilises Proportional-Integral-Derivative (PID) loops and their associated algorithms connected to sensors to respond to conditions with incremental adjustments to actuators, valves, fans and pumps. Problems in these systems can result in poor valve performance. Common control system problems include:

- Noise in the control signal – interference or poor wiring disrupts the signal, impairing communication between valves and other systems
- Incorrect valve sizing and sensor-to-room pairing, or sensors out of calibration
- Too much pressure at the valve inlet – this can cause the system to be noisy or the valves not to close off properly; the pump control system is unable to regulate pump head pressure affecting proper valves operation and ultimately energy efficiency
- Improper response to temperature changes – this will manifest itself through seasonal outdoor temperature changes (loads), equipment set point temperatures, or how the system is tuned to respond.

All of these are design or system variables or conditions that the BMS has some level of

control over. Control loop hunting, referred to above, can be difficult to detect and occurs when the valves/actuators are maintaining temperatures within tight parameters (e.g. +/- 0.5°C), but the control loop is unnecessarily cycling between heating to cooling every few minutes. Seasonal tuning can ensure all loops are stable by monitoring the control temperatures and valve positions over a time period, either on site next to the AHU or from the BMS terminal.

Valve and actuator inspections

To avoid the problems described above, valve and actuator inspection should be incorporated as part of a regular proactive, predictive maintenance strategy. Although reactive maintenance is the most popular approach, the highest performing facilities overwhelmingly use preventative maintenance and rarely utilize reactive maintenance.

According to U.S. government figures, comprehensive operations and maintenance programs, based on proactive, predictive maintenance combined with analytics, can save up to 20% per year on maintenance and energy costs, while increasing the projected lifetime of the building by several years. The key to predictive maintenance is that equipment and system conditions determine what maintenance is performed, as opposed to a preset schedule. This means that repairs are performed at the ideal time, resources are not wasted on unnecessary work and equipment (including valves and actuators) is maintained at its highest performance levels.

Predictive maintenance can leverage automated sensors and expert knowledge to help prioritize overall system and valve and actuator maintenance. Taking this concept a step further, integrating all of the data coming from the BMS and connected devices with advanced analytics capabilities creates a true 'smart service plan' approach.

The plan provides accurate information about facility issues and then ranks them by how they impact the business in different areas such as energy cost, comfort and maintenance urgency.

Since most buildings today are 'smart' to some degree – meaning they have some type of BMS capability – implementing a 'smart' service plan is a natural next step.

Such a plan allows the facility to leverage the data that the BMS collects and put it to use in new ways to reduce energy use and overall costs.

This overall system maintenance approach also ensures that control valves are operating as

designed and that control loops are tuned and optimized for energy efficiency. If using an outside company to service equipment, valve inspection should be part of the service agreement.

More on the value of a predictive maintenance strategy for building operations, including regular valve and actuator inspections, can be found in the Schneider Electric white paper, "Predictive Maintenance Strategy for Building Operations: A Better Approach."

Inspection best practices

Inspections can be performed in various ways, depending on resources and building type:

- Simple visual inspection of the control valve and actuator can be an effective way to detect obvious mechanical problems. This approach is challenging in a facility with hundreds of valves, but the inspections can be scheduled throughout the year to make them manageable. Visual inspection may be especially difficult in some office spaces or hotel rooms where the control valve is not readily visible and may require a panel or ceiling tile be removed in order to access
- Visually checking trend logs in a BMS terminal can help to detect anomalies in equipment performance, to be followed up with physical inspection where indicated.
- The above inspection techniques can be augmented by using building analytics tools, which offer a precise methodology for monitoring energy waste through control valves. Analytics can identify possible valve problems that would otherwise be difficult to detect.

In all cases, when an inspection is performed, it is good practice to include photographs of system conditions to support the engineer's report, which can be referred to on subsequent inspections.

The following steps are recommended as part of an effective valve inspection program:

Checklist for valve inspection

- Test for control loop stability by monitoring the control temperatures and valve positions over time either at the plant room or from the higher level BMS to which the devices are connected
- Create a trend graph with valve/damper actuator positions, available temperature (supply, discharge and space) and observe that the heating and cooling systems are functioning as designed during normal operation. If irregularity is observed, such as hunting or temperature response, then tune the control loop accordingly

- Visually check the valve for leakage
- Close the drive valve and allow time for the downstream temperature to stabilize. Then check with a temperature probe to establish the valve is shutting off. If there is evidence of let-by then investigate further
- Check for valve stem showing signs of weeping around the gland. If present, replace gland kit or entire valve
- Look for signs of galvanic corrosion on valve body and pipe work. This can lead to leaking and requires wire brushing and anti-corrosive paint applied or the connection remade in severe cases
- Check valve bonnet for evidence of scoring, likely caused by faulty actuator mounting; tighten accordingly
- Check for rattling sounds (preferably use acoustic listening device) which can indicate the plug becoming detached from the stem. If necessary, replace stem and plug assembly or entire valve.

Note that steam valves are especially important to check regularly. They can be more prone to stem failure from internal steam pressure or condensation when open, often resulting in worn plugs or seals or even broken plugs or stems. Special precautions and additional care should be taken when inspecting/working with steam control valves.

Checklist for valve and damper actuator inspection

- Cycle actuators from open to close by changing the control signal from the BMS; then check the fail return for correct operation
- Check that linkages/anti rotation brackets are tight and not showing any signs of wear or play
- Check if the actuator has a bent anti-rotation plate and replace if needed. This could be caused by excessive force used on manual override
- Check that the actuator linkage or anti-rotation bracket is touching the position indicators. If not, it is likely the actuator has come loose or that sediment is present in the valve stopping it from closing. Check that the actuator has enough force to close
- Test the manual override operates correctly and is disengaged at the end of the inspection
- Look for fading colors on the position indicator. This can indicate very high ambient/operating temperature leading to premature failure

- Listen for excessive noise in the actuator, which could indicate it has been operating for too long. This could be due to a poor control loop or no time-out facility on floating control, either of which could cause potential premature failure
- Check to see if the actuator is driving closed and repeatedly trying to close the valve. This indicates the valve has dirt contaminants or simply needs recalibrating.

Conclusion

Valves and actuators are critical components in a building's environment. They typically control approximately 35% of a building's energy systems. To ensure control stability and energy-efficient operations, valve inspections should be part of a regular proactive, predictive maintenance strategy that leverages data and analytics to enhance performance. Regular inspection and servicing

of valve assemblies will help ensure longer equipment life, lower energy bills, and a more comfortable and safe environment for occupants. An industry expert, such as Schneider Electric, can provide advice as to how service agreements can cut costs and enhance operational efficiency. ■

Credits
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Scientists To Collect Data On Supercooled Water

Sandia National Laboratories researcher Darielle Dexheimer and her colleagues Erika Roesler and Joe Hardesty are using balloon-borne instruments to learn more about supercooled liquid water in the Arctic atmosphere...

Supercooled water sounds smooth enough to be served at espresso bars, but instead it hangs out in Earth's atmosphere, unpredictably freezing on airplane wings and hampering the simulations of climate theorists.

To learn more about this unusual state of matter, Sandia National Laboratories atmospheric scientist Darielle Dexheimer and colleagues have organised an expedition to fly huge tethered balloons in Alaska this coming winter, where temperatures descend to 40 degrees below zero and it's dark as a dungeon for all but a few hours of the day.

"We'll start in November and see how it goes," said Dexheimer.

Supercooled liquid water is pure water that remains a liquid below its normal freezing point because it has nothing to nucleate around. The idea is to gain a large dataset about it, uncollected elsewhere, to fine-tune the accuracy of climate models and reduce the number of ice-delayed flights and crashes. The team collected data from tethered balloons in Alaska last year, but didn't operate later than October.

The team will wrest more data about the presence and behaviour of supercooled liquid

water where it is most plentiful and at a location most crucial to climate modelers: Oliktok Point at the tip of oilfields of Prudhoe Bay, one of the northernmost points of the United States. ■

Ice pops from a balloon's tether line as researcher Darielle Dexheimer gathers in an instrumented balloon at the Atmospheric Radiation Measurement research station at Oliktok Point, Alaska. The balloon is about 25 feet above Dexheimer's head and the lines are completely iced over...



Photo Courtesy: Darielle Dexheimer

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Importance Of Cold Chain

In National Agro Economy

Extension efforts and training needs to differ by target group, and there are often difficulties in reaching smallholder farmers, women, youth, middlemen/traders and processors. Traders and middlemen have been generally ignored...

Global food losses have been documented to be on the order of 25% to 50% of production volumes, caloric content and/or market values depending on the commodity (Lipinski et al, 2013; Gustavsson et al 2011; IIR 2009). The use of "cold" handling and storage systems as an investment to prevent perishable food losses is widely used in developed countries and can be highly cost effective compared to continually increasing production to meet increasing demands for these foods. The use of cold technologies in the development of agricultural supply chains for meat, dairy, fish and horticultural products in the USA and EU countries began the early 1950s along with the growth of the mechanical refrigeration industry, but cold chains are still limited in most developing countries.

There are many technical, logistical and investment challenges as well as economic opportunities related to the use of the cold chain. The primary segments of an integrated cold chain include 1) packing and cooling fresh food products, 2) food processing (i.e. freezing of certain processed foods, 3) cold storage (short or long term warehousing of chilled or frozen foods), 4) distribution (cold transport and temporary warehousing under temperature controlled conditions) and 5) marketing (refrigerated or freezer storage and displays at wholesale markets, retail markets and foodservice operations). Policy makers in the agriculture, energy, education and food sectors must work together to promote the use of cold chain technology, improve logistics, maintenance, services, infrastructure, education and management skills, and create sustainable markets for the design, use and funding of cold chains for reducing perishable food losses.

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chilled or frozen foods), 4) distribution (cold transport and temporary warehousing under temperature controlled conditions) and 5) marketing (refrigerated or freezer storage and displays at wholesale markets, retail markets and foodservice operations). Policy makers in the agriculture, energy, education and food sectors must work together to promote the use of cold chain technology, improve logistics, maintenance, services, infrastructure, education and management skills, and create sustainable markets for the design, use and funding of cold chains for reducing perishable food losses.

Fresh foods continue to metabolize and consume their nutrients throughout their shelf life, from harvest or slaughter through packing, distribution, marketing and sale. Carbohydrates, proteins and other nutrients are broken down into simpler compounds often resulting in reduced quality or quantity of the foods, through respiration, enzymatic breakdown and microbial degradation. All of these processes are highly dependent upon temperature.

As is the case for all biological processes, the higher the temperature the faster these natural degradation processes will occur, leading to loss of color, flavor, nutrients and texture changes. In fact, as a general rule, most of these degradation processes double their rate for each increase of 10°C (known as the Q10 quotient, which is illustrated in more detail below). For example, maintaining a food's temperature at 10°C colder than the temperature commonly experienced when handled during ambient conditions can double the shelf life of that food. Lowering temperature does have some exceptions, since some fresh horticultural perishables are susceptible to chilling injury below about 10°C (most of the tropical and sub-tropical crops) and all fresh horticultural perishables will freeze below about -1°C.

In addition to physiological deterioration, foods may host micro-organisms such as bacteria and fungi which can cause molds, rots or decays, and are subject to water loss which results in wilting, shriveling

Table 1: The Cold Chain, Food Security and Economic Development Variable...

	Global	Developed countries	Developing countries
Population in 2009 (in billions of inhabitants)	6.83	1.23	5.60
Population in 2050 (forecast, in billions of inhabitants)	9.15	1.28	7.87
Refrigerated storage capacity (m3/1000 inhabitants)	52	200	19
Food losses (all products)	25%	10%	28%
Losses of fruits and vegetables	35%	15%	40%
Losses of perishable foodstuffs due to lack of refrigeration	20%	9%	23%

Table 2: Predicted loss of storage potential increases as handling temperatures increase for fresh foods commonly handled at ambient temperatures in developing countries (rough calculations based upon Q10 coefficients)...

Food product	Storage potential			
	at optimum cold temperature	optimum temperature + 10°C	optimum temperature + 20°C	optimum temperature + 30°C
Fresh fish	10 days at 0°C	4 to 5 days at 10°C	1 to 2 days at 20°C	A few hours at 30°C
Milk	2 weeks at 0°C	7 days at 10°C	2 to 3 days at 20°C	A few hours at 30°C
Fresh green vegetables	1 month at 0°C	2 weeks at 10°C	1 week at 20°C	Less than 2 days at 30°C
Potatoes	5 to 10 months at 4 to 12°C	Less than 2 months at 22 °C°	Less than 1 month at 32 °C	Less than 2 weeks at 42 °C
Mangoes	2 to 3 weeks at 13°C	1 week at 23°C	4 days at 33°C	2 days at 43°C
Apples	3 to 6 months at -1°C	2 months at 10°C	1 month at 20°C	A few weeks at 30°C

or darkening. Both the rate of microbial growth and the rate of water loss occur more rapidly as temperature increases. Few other interventions can so dramatically maintain the visual quality and nutritional value, and increase shelf life and ultimate market value of fresh foods as much as simply holding the foods at a lower temperature.

Cooling provides the following benefits for perishable horticultural foods:

- Reduces respiration: lessens perishability
- Reduces transpiration: lessens water loss, less shriveling
- Reduces ethylene production: slows ripening
- Increases resistance to ethylene action
- Decreases activity of micro-organisms
- Reduces browning and loss of texture, flavour and nutrients
- Delays ripening and natural senescence

In general, the Q10 coefficient (an indication of the relative rate of respiration at 10°C intervals) can be used for fresh foods to estimate the shelf life under different temperature conditions.

Use of cold chains

A cold chain for perishable foods is the uninterrupted handling of the product within a low temperature environment during the postharvest steps of the value chain including harvest, collection, packing, processing, storage, transport and marketing until it reaches the final consumer. An integrated cold chain encompasses the management of the movement of perishable food products from the field, ranch or body of water through the entire postharvest chain to the final consumer. The primary segments of an integrated cold chain, which include 1) packing and cooling fresh food products, 2) food processing (i.e., freezing of certain processed foods), 3) cold storage (short or long term warehousing of chilled or frozen foods), 4) distribution (cold transport and temporary warehousing under temperature controlled conditions) and 5) marketing (refrigerated or freezer storage and displays at wholesale markets, retail markets and foodservice operations) can be simple or complex, low tech or high tech. Cold chain logistics is the planning and management of the interactions and transitions between these five segments, in order to keep foods at

their optimum temperature for maintenance of quality, food safety and prevention of waste and economic losses. Speed is often the key to success when handling and marketing perishable foods using a cold supply chain (Kohli 2010).

The cold chain is a well-known method for reducing food losses and food waste, and has long been promoted by established industry focused organizations such as The International Institute of Refrigeration (www.iifir.org), The World Food Logistics Organization (www.wflo.org) and the Global Cold Chain Alliance (www.gcca.org). The required infrastructure and investments in needed facilities, equipment and management skills, however, are generally lacking in developing countries. Policy studies on food make very little mention of "postharvest" aspects of agriculture in major new reports on farming or small and medium scale enterprise (SME) policy coming from international donors and grant-makers. Recent examples include the FAO's State of Food and Agriculture 2010-11 and IFPRI's Food Security, Farming, and Climate Change to 2050: Scenarios, results and policy options, which when searched provide no references to postharvest problems, cold chain issues, opportunities or policy options. The UNFAO/UNIDO manual on Agro-Industries for Development (da Silva et al 2009) mentions the term "cold chain" only once in a comprehensive work of 270 pages.

The UN FAO recently launched the SAVE FOOD Initiative which includes many partner organizations working on various means for reducing food losses and waste. One of the top priorities cited by the Global Harvest Initiative report on measuring global agricultural productivity was "Improving food system infrastructure and processing to benefit agricultural products distribution and minimize waste" (GHI 2010; p. 8). The report concludes that significant public and private investments in capital and infrastructure will be required along the entire food chain. Reports on the postharvest sector and its contributions to economic development (Mrema & Rolle 2002; Kader 2006; Winrock 2009) leave no doubt as to its importance and cost effectiveness, yet introducing a cold chain in a developing country requires the integration

Table 3: Theoretical relationship between temperature, respiration rate and deterioration rate of a non-chilling sensitive fresh commodity...

Temperature °C	Assumed Q10	Relative velocity of deterioration	Relative shelf life	Loss per day (%)
0	–	1.0	100	1
10	3.0	3.0	33	3
20	2.5	7.5	13	8
30	2.0	15.0	7	14
40	1.5	22.5	4	25

Table 4: Examples of mechanical technologies available for refrigeration/freezing...

Cold chain step	Small-scale	Large scale
Pre-cooling systems	Portable forced air cooling systems	Vacuum cooling Forced air cooling Hydro-cooling
Cold Storage	Walk-in cold rooms CoolBot™ equipped cold room	Refrigerated warehouses
Processing- chilling or freezing	"Direct expansion" chilling of bulk milk "instant" chilling of milk	Blast freezing IQF Vacuum cooling of packaged meats
Refrigerated transport	USDA Porta-cooler	Reefer vans Refrigerated marine containers Refrigerated intermodal containers (for road, rail and sea shipping)

of a great many different elements and the continuing management of those elements. Unfortunately, most aid donors and grant programs have tended to focus on establishment of stand-alone cold storage or food processing facilities or projects rather than focusing on the longer term management of those investments and the maintenance of an integrated cold chain.

Selecting appropriate cooling technologies for use in the cold chain

There is a wide range of options and technologies for producing cold conditions for food handling, processing, storage and transport. Some are relatively simple and inexpensive, while other technologies intended to achieve the same results are more sophisticated and complex to manage. For precooling, operators can choose from simple farm-based methods such as using ice, to more complex systems for forced air, hydro-cooling or vacuum cooling. For storage, there are options for food handlers that range from small walk-in cold rooms to large scale commercial refrigerated warehouses. Small-scale cold rooms can be designed using traditional mechanical refrigeration systems, low cost CoolBot™ equipped air-conditioner based systems (see detail below), or as evaporative cool chambers. Food processors can choose from chillers, blast freezing, IQF, freeze drying and many other technologies. During transport, cold can be provided via the use of ice, trailer mounted refrigeration systems, evaporative coolers or via passive cooling technologies (insulated packages or pallets covers during transport).

The suitability of these options will depend upon the food products being handled and the level of sophistication of the value chain. Kitinoja and Thompson (2010) and Winrock International (2009) have reviewed the cooling practices utilized during pre-cooling and cold storage for horticultural crops. These documents provide basic recommendations

on cooling options and information regarding capital costs and energy use for small-scale, medium scale and larger scale operations. In general, the highest cost will be for mechanical refrigeration systems using electricity or diesel fuel where temperatures are the hottest, but the benefits of using cold chain technologies can still outweigh costs, since it is in these regions where food losses due to lack of temperature management are the highest. Evaporative cooling systems work well only in dry regions or during the dry seasons when the relative humidity is low. Total construction and operating costs for refrigerated systems will vary widely depending on the costs of local materials, labor and electricity. Postharvest losses can be greatly reduced with the use of cold storage, but the ROI for any specific operation will always depend largely upon the market value of the food commodities being cooled and stored and the use efficiency of the facility (i.e. whether or not it is operated at full capacity).

Evaporative cooling: Lowering temperature of fresh horticultural produce via systems utilizing the evaporation of water to 2-3°C above the ambient dew point temperature. Evaporative cool storage rooms are commonly used for bulk storage of tropical and sub-tropical crops (such as sweet potatoes) or as small-scale cool chambers for temporary storage of fruits and vegetables in tropical climates, and work best in dry climates or during the dry season. Evaporative coolers can be passive (zero energy) or assisted (using a solar powered or electric fan to move air through the storage chamber).

Training and capacity building for cold chain development

A recent review of cold chain development points out that "Even in many regions or sites where adequate infrastructure is available, overall knowledge of proper cold chain practices, maintenance (including

Table 5: Examples of Non-mechanical technologies available for cooling...

Cold chain step	Small-scale	Large scale
Pre-cooling systems	Portable evaporative forced air cooling systems	Slurry ice
Cold Storage	Zero energy cool chambers (ZECC) Evaporatively cooled cool rooms (charcoal coolers) Underground storage (root cellars) Night air ventilation High altitude storage Radiant cooling Solar chillers	Evaporatively cooled warehouses Underground storage (caves) High altitude storage Radiant cooling
Processing- chilling and freezing	None available	None available
Refrigerated transport	Evaporatively cooled insulated transport boxes or trailers	Passive cooling (insulated pallet covers)

availability of spare parts), and applications are weak in most of the developing world, and it is generally worst in facilities owned or operated by government than in facilities owned or operated privately" (Yahia, 2010). Yahia (2010) also reports, "There has been reasonable growth in cold chain infrastructure in Morocco, Egypt, and lately in Libya, but in all [developing countries] there is still major room for growth and much great efforts to improve capacity training to form better technicians and to improve applications."

Extension efforts and training needs to differ by target group, and there are often difficulties in reaching smallholder farmers, women, youth, middlemen/traders and processors. Traders and middlemen have been generally ignored although they have a large impact on temperature management during handling and transport, and therefore upon the final quality of foods and their potential market value. Future extension efforts should seek to include this group of men and women in efforts aimed at adopting the use of the cold chain (Kitinoja et al 2011).

Training topics should include:

- Commodity systems assessment s (identifying the causes and sources of losses)
- Basic practices for reducing losses for perishable foods intended for cold storage
- Technical subjects along the cold chain (postharvest handling, refrigeration, cold storage, cold transport, food processing, etc.)
- Value chain development (processes and practices)
- Management topics (managing labor, equipment, finances, risk, marketing, etc.)
- Logistics (interactive complexities of managing a cold chain system)
- Engineering (including design, modifications, repairs, maintenance of cold technologies)
- Food safety issues (including the potential impact of poor food safety)
- Environmental issues
- Energy efficiency

Capacity-building efforts undertaken in cold chain technology must be made more comprehensive, and include technical knowledge on handling practices, research skills, access to tools and supplies, cost/benefit information, extension skill development (training needs assessment, teaching methods, advocacy), internet/web access, use of IT and cell phones for information sharing and provision of follow-up mentoring for young scientists and extension workers after formal training programs have been completed (Kitinoja et al 2011). And since training and capacity building needs will shift over time as changes occur in agricultural value chains and cold chains, continual formative evaluation to improve programs is needed to ensure capacity building efforts continue to meet the needs of target audiences.

Conclusions and recommendations

The use of cold is not a cure-all or a one-size-fits-all proposition, but is an important component of an agricultural handling system or value chain in its entirety. Each type of fresh produce and/or food product has a specific and limited storage potential related to its physiological nature and lowest safe storage temperature, and the use of the cold chain can help reach this potential and reduce perishable food losses. Misuse of cold will lead to higher food losses along with added financial losses associated with the costs of cooling, cold storage, cold transport and refrigerated retail market displays.

At present, the term "cold chain" is used interchangeably when referring to a value chain for fresh tropical produce (at 12 to 18°C),

chilled fresh produce and food products (at 0 to 4°C), or frozen food products (at -18°C). Costs are much lower, however, when investing in and utilizing a cool chain for fresh tropical and sub-tropical produce, this difference needs to be better understood by public sector planners and private sector investors.

The term "cool chain" should be used when describing the agricultural value chain for handling and distribution of fresh tropical fruits and vegetables. Cool chain investments in simple, low cost technologies such as evaporative pre-cooling, zero energy cool chambers and night-time ventilated cool storage structures are cost effective and easy to manage, leading to increased profits.

At present, the use of the cold chain is often avoided by food producers, handlers and marketers due to its perceived high cost. Yet when 25 to 50% of foods are wasted after the harvest, the real cost of production is much higher than it should be. Using "cold" as an investment to prevent food losses can be highly cost effective in comparison to continually increasing production to meet increasing demands for foods. Information on the costs of using the cold chain and on the expected benefits in terms of increased volumes of food available for sale, increased market value and improved nutritional value should be gathered and made readily available to potential users and investors.

Most developing countries currently lack the basic infrastructure and educational program needed to support the development of an integrated cold chain for distribution of perishable foods. The public sector should provide funding for investments in basic infrastructure to support cold chain development (i.e. electricity, roads), and for educational programs at the primary, secondary and higher educational levels in order to promote the value of production, handling and consumption of high quality, safe and nutritious foods. Governments should limit disincentives (for example high taxes on imported refrigeration equipment) and invest in those components of infrastructure and education that are currently missing in their development efforts involving cold chains.

The use of the cold chain is often avoided by food producers, handlers and marketers due to its perceived complexity and logistical challenges. There is a need to promote awareness and local, national, regional and international capacity building and training of trainers in the proper use of the cold chain. Once the cold chain is in operation, regular access to technical training on cold chain management and cold supply chain logistics will be needed by both the public and private sector.

Currently the lack of the use of the cold chain in developing countries leads to high food losses and loss of market value, leaving little profit for farmers, handlers, processors or marketers, while promoting the development of cold chains, could be a good source of new jobs. Producers would benefit as the agricultural value chains for their food products are fully developed, and new jobs would be formed all along the cold chain for those perishable foods for which pre-cooling, cold handling, freezing, cold storage and refrigerated distribution and marketing have been demonstrated to be cost effective.

Historically cold chains are often developed and utilized first for exports of higher value commodities and food products, but once in place are also used for domestic handling and marketing. Where cold chains exist for exported food products, they can be used as models for education, capacity building and skill development, and expanded to include cold storage and refrigerated distribution of perishable foods for domestic markets. Using the cold chain for improving domestic food supply chains will lead to improved nutrition and food safety while reducing food losses and lowering market prices for the local population.

Finally, we need to promote the use of cold chains as a means to prevent the waste of limited natural resources. The resources required for agricultural production (i.e. land, water, fertilizers, fuels, other inputs) are becoming more scarce and costly, and 25% to 50% of the resources used to grow these foods are being wasted when perishable foods are lost before consumption. Investments in the cold chain prevent the loss of foods after they have been produced, harvested, processed, packaged, stored and transported to markets, which greatly reduces the need for increased production to meet the predicted growth in future demand. Reducing food waste also saves the water, seeds, chemical inputs and labor needed to produce the food that is currently being lost. As local and global resources become scarcer and more expensive, preventing food losses will become even more cost effective than it is at today's resource prices. Public and private sector investors need to take into consideration how investing in the use of the cold chain can generate savings due to the reduced need for constantly increasing food production to meet rising consumer demand for perishable foods.

The Task Force on cold chain development in India had suggested in its report to establish a National Centre for Cold Chain Development (NCCD) in India as an autonomous centre for excellence to be established as a registered society to work in close collaboration with industry and other stake holders to promote and develop integrated cold chain in India for perishable F&V and other perishable allied agri – commodities to reduce wastages and improve the gains to farmers and consumers substantially.

As recommended by the Task Force on Cold Chain a National Centre for Cold Chain Development (NCCD) has been established to promote and develop integrated cold chain in India for perishable agriculture and horticulture produce including perishable from allied sectors. The main objectives of the centre are to recommend standards and protocols for cold chain infrastructure, suggest guidelines for human resource development and to recommend appropriate policy frame-work for development of cold chain.

NCCD was registered as a society under Registration of Societies Act 1860 on 27.01.2011. Cabinet Committee gave post facto approval on 09.02.2012.

In conformity with the vision of the Task Force on Cold Chain Development in India, set up by Ministry of Agriculture, the NCCD is mandated to recommend technical standards for cold chain infrastructures for perishable food items including fresh fruits & vegetables and undertake their periodic revision keeping pace with technological advancements. It is also going to undertake consultancy work, certification of cold storages and their ratings, Applied R & D and Human Resource Development Programmes for meeting requirement of skilled man-power of the cold chain sector in the Country. It is also going to advise Government in the matters relating to development of integrated cold chain infrastructure in the Country. This will definitely help in reducing post harvest losses of perishable farm produce and ensuring their steady availability thereby, securing remunerative price of farm produce to producer-farmers and availability of fresh fruits & vegetables to consumers at affordable prices.

- Alternate Energy Options for Strengthening Energy Efficiency for Cold Storage
- Current Scenario
- India is the largest producer of fruits and milk
- Second largest producer of vegetables

Third largest producer in the fishing sector in the world.

Problem	Solution
Post harvest losses :25 –30% ; Due to lack of proper storage and transit facility	Perishable produce requires cold chain arrangement to maintain quality,extend shelf life.
No access to grid power, Unreliable grid power supply, Storages use grid power hybridized with DG sets	Alternate energy sources to complement grid tied storages, also projects havebeen developed to feed back into the grid

A typical cold chain An alternate approach...

Harvesting → Pre-cooling → Transportation → Sorting / Treatment → Packaging → Pre-cooling → Long transportation → Cold Storage → Retail

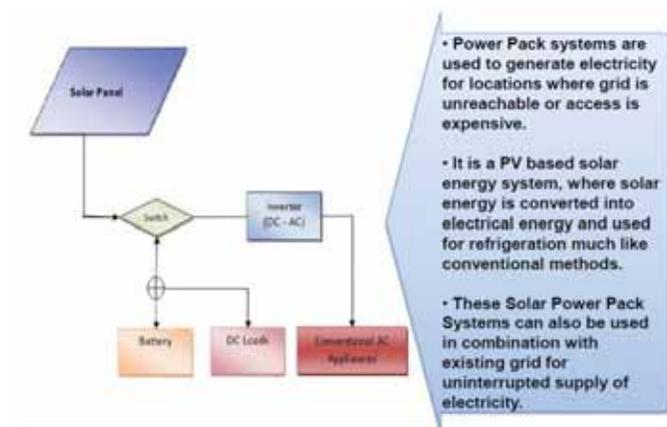
There is vast scope for applying renewable energy options will ensure self sustained, environment friendly, economical development of GREEN COLD CHAIN in long run facilitating further the increasing production.

R E Technological options

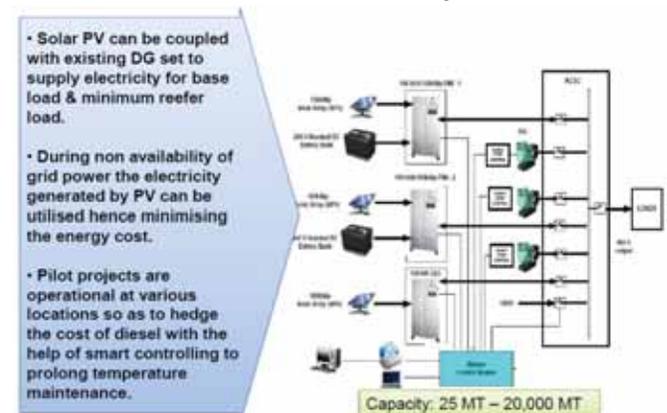
- Solar Photovoltaic Power Pack
- Solar PV + PCM
- Solar PV System + Diesel Gen-set Hybrid
- VAM Using Solar Thermal Energy
- Biomass Gasifier
- Solar/Biomass Co-generation (Power and Cooling)

These are some ready and proven options available

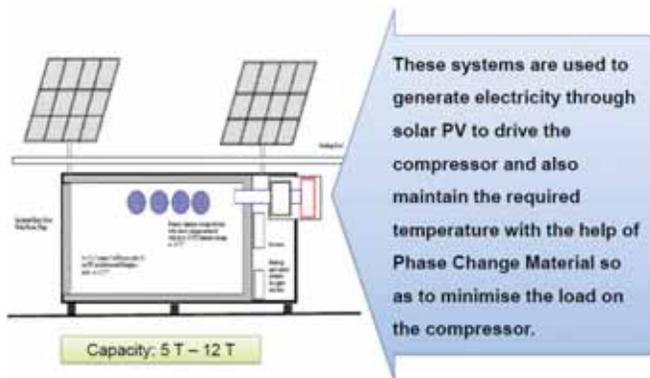
Solar Photovoltaic Power Pack...



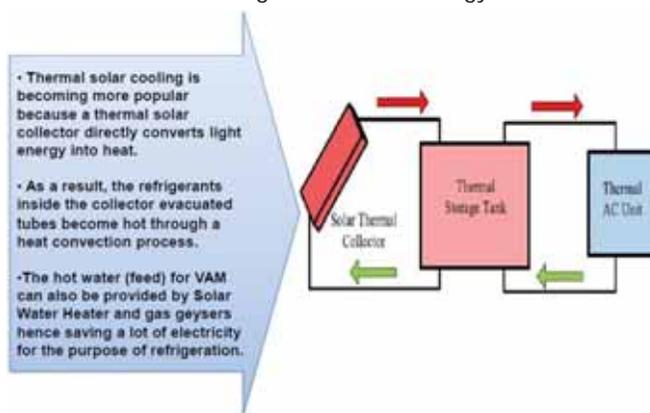
Solar PV + Diesel Genset Hybrid...



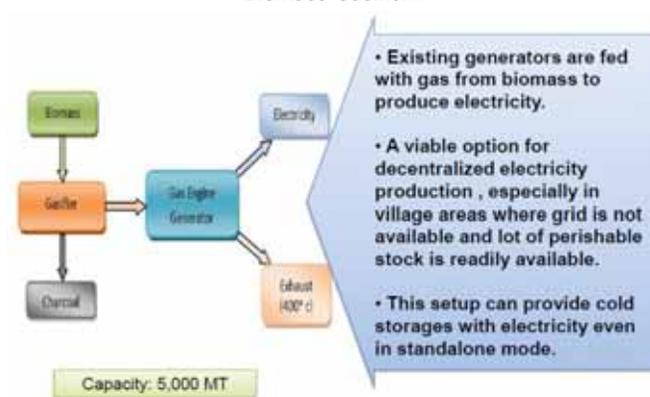
Solar PV + PCM



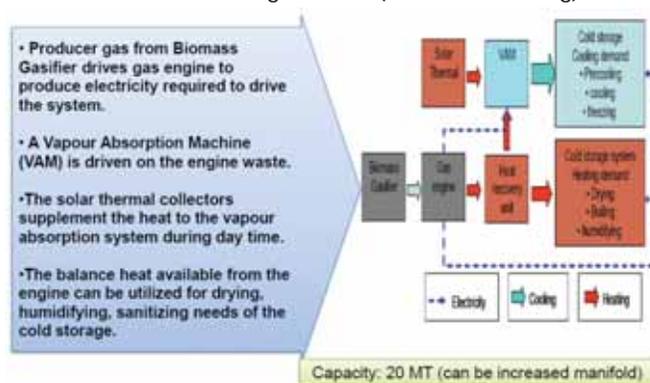
VAM using Solar Thermal Energy...



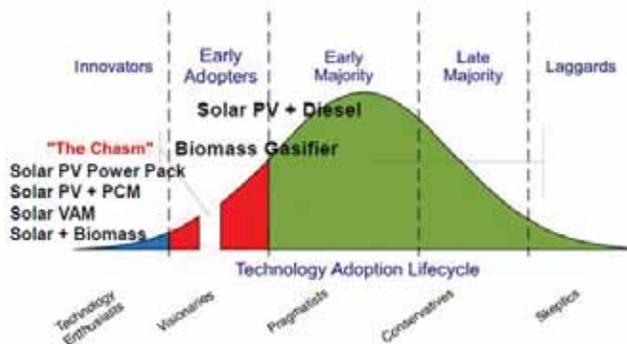
Biomass Gasifier...



Solar / Biomass Co-generation (Power and Cooling)...



Techno-economic adoption...



Pilot projects, Successful implementations...

Technology	Technology partners	Project location
Solar PV System + Diesel Gen-set Hybrid	MARFIN	167 Projects executed in Bihar and North East
Solar Thermal-Biomass gasifier	TERI – Thermax-MNRE	Solar energy Centre, Gurgaon
Biomass gasifier	MNRE initiative in Bihar	7 Cold storage running in Bihar of capacities upto 5000 MT

Other R E solutions for food processing...

Solar thermal technologies can also be used for other processes requiring (temperature up to 150°C) such as Cleaning, Blanching, Dehydration and Drying.

Various projects under these technologies have been running successfully throughout the country. Some of the key projects:

Process	Temp.	Technology	Few existing projects
Blanching / Pasteurization	70	FPC	Mahanand Dairy, Chitale Dairy
Dehydration	70-80	ETC (Air heater)	55m2 area solar for mango concentrate at Eluru, Andhra Pradesh
Drying	70-80	ETC (Air heater)	9 tea factories having a total collector area of 2,420m2
			Over 150 installation by SEED
			Chief Horticulture Office, Ladhakh & Kargil

Role of ministry

- Promoting various technological options
- Preparing DPRs and assisting on technological aspects
- Greater synchronization and synergy in between various ministries and departments
- Promoting and enabling policy formulation and integration of RE in various policies
- Expected impact and outcome
- Maximize Price Realisation (farmers / storage owners)
- Prevent Wastage
- Improve Shelf Life (Exotic flowers/vegetables)
- Improve Productivity
- Reduction in dependence on conventional energy
- Reduce logistics cost

Dr. Omprakash G. Kulkarni
 Scientist, Mentor, Adviser, Technology Provider and Consulting Engineer for Renewable Energy and Others...



High Efficiency

Chest Freezers & Coolers

Experiments conducted suggest that there is at least an increase of 6 to 7% in the CoP (Coefficient of Performance) of any refrigeration system with the use of Phase Change Materials (PCM)...

World's increasing energy demand forces us to brainstorm for new and innovative methods, which allow us to save the precious earthly resources, while maintaining the performance parameters of any technology. The depleting coal resources have also given us the indication that the time is right for such endeavours. After understanding the gravity of the above-mentioned situation, an important question to ask would be "what are Phase Changing Materials (PCM)?" This question beholds a significant understanding of energy saving and appropriate energy utilization. Analogous to the battery, where a constant voltage is supplied in the absence of the electrical supply, the Phase change materials provide constant temperature application in the absence of thermal source or sink depending upon the scope of application.

A phase change material absorbs energy, stores it in the form of latent heat and utilizes wherever necessary.

They maintain constant temperature while changing their physical form i.e. from liquid to solid or vice versa (figure 2). Phase changing being a reversible process, the high energy density (figure 1) behaves as a thermal reservoir which can be used repeatedly.

"The food wastage & cold storage infrastructure relationship in India" – a report published by Emerson Climate Technologies clearly states that "India, the world's largest producer of milk and the second-



largest producer of fruits and vegetables, is also one of the biggest food wasters in the world –wasting INR 440 billion worth of fruits, vegetables and grains every year. India definitely needs a proper cold storage infrastructure. The rest part of the article will try to explain the importance of PCM in freezers, which forms an integral part of the cold storage industry.

Market Scope of PCM

Increasing demand for energy saving and innovation for green technologies is driving the scope for growth of PCM market. With the leaders of all the countries going green after the historical event of 2015

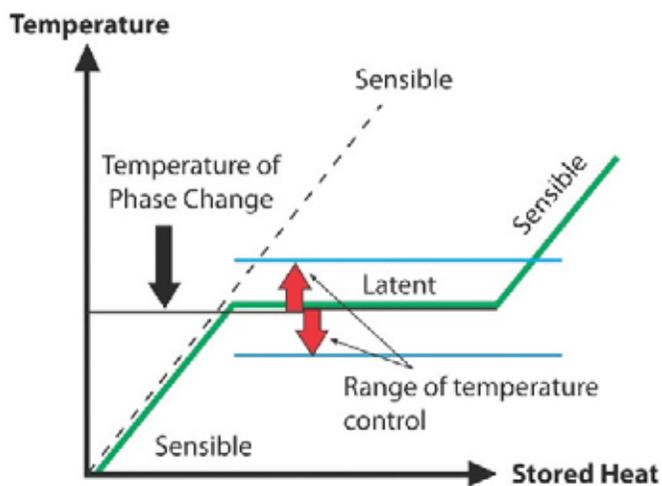


Figure 1: Sensible heat vs Latent Heat...



Figure 2: Concept of heat storage...



Figure 3: PCM based Chest freezer...

“United Nation Climate change conference, setting a maximum temperature for global warming at 1.50C and reducing the emission to 40% by 2030. Achieving these parameters requires a need to revolutionize our current technologies.

The major application driving the PCM market is the building and construction with an annual revenue of \$415.5 Million(2015) which is then followed by commercial refrigeration with a revenue of \$286 Million(2015) with a CAGR of 36% and 30% from 2008 to 2015 respectively [Market-Global Forecast (2010-2015)].

In 2015, the commercial refrigeration constitutes for 20% of total PCM market which shows no significant improvement from 19% in 2008. Studying for such parameters increases the curiosity for exploring our interest in the commercial refrigerators, mainly in the form of deep freezers. A lot of innovation can change the way we look at the refrigeration now, like frictionless compressors, magnetically driven compressor, PCM or even the Peltier effect. Out of all, PCM is the only technology currently available and can be utilized in replacing Glycol-water mixture for higher retention time.

In the last 4 years since 2013, more than 30,000 PCM-based Chest freezers and coolers were have been launched in the market by major OEMs in the refrigeration space. Each PCM based freezer/cooler provides over 5000 hours of temperature control during the power outage annually. These numbers are only a miniscule in comparison to the total market size of chest freezers and coolers and hence the potential for this segment to grow is very large. Proper Initiatives in research & development, strategic scheduling and marketing can easily broaden the horizons for Phase change materials.

Design and Evaluation of the PCM based Deep Freezers

Experiments conducted suggest that there is at least an increase of 6 to 7% in the COP (Coefficient of performance) of any refrigeration system with the use of Phase Change Materials (PCM) [performance improvement of a domestic refrigerator by using phase change material].

The use of PCM pouches perfectly wrapped around the evaporator coils increases the evaporator temperature and hence the energy efficiency is increased. The energy stored in the PCM is utilized after the compressor cuts-off therefore maintaining a long retention time. Glycol-water mixture based deep freezers have ruled over the entire market for years. They readily give the retention period of 4-5 hours but do not maintain the precise temperature during this retention period.

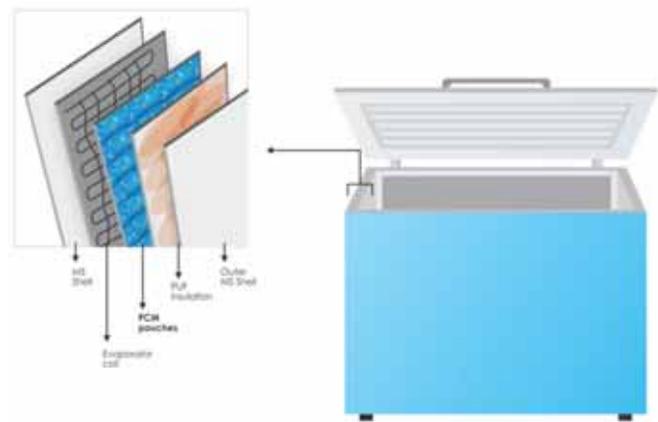


Figure 4: Pouch installation in deep freezer...

Depending on the evaporator coil temperatures and required temperature inside the chamber an appropriate phase change material is chosen. The encapsulation and integration within the freezer and cooler need to be evaluated based on the type of system and limitations in the manufacturing processes of the OEM.

Key Advantages

- Annual electricity saving of 25% or more due to longer compressor cut-off period.
- Reduces weight of 10% or more, when compare to similar Glycol-water base Deep Freezer.
- Longer retention time; suitable in longer power outages of upto 16 hours.
- Precise temperature control of $\pm 20C$.
- Larger shelf life, 3000 thermal stability (cycles) guaranteed, which translates to a period of 8-9 years.
- Lowers the risk of transportation – PCM encapsulated in modules.
- The yearly saving per 1100 Liter machine is around 10,000 INR with a payback period of less than 2 years.
- Considerable reduction in greenhouse effect.

Conclusion

Increasing demand for an effective and clean technology should be properly handled by taking initiatives which can cater to industries and the people using it at large. Government enterprises and the private players should together implement ideas for the development of PCM based refrigeration systems. Awareness is the key, proper knowledge session by making people literate about the technology should be included in the cold storages or refrigeration conferences/summits nationally. ■



The Best

Sustainable Technology

According to the weather data in cold regions, the air-source heat pump for heating applications must operate for long times with high efficiency and reliability when ambient temperature is as low as -15°C . Hence, much researches and developments has been conducted to enable heat pumps to operate steadily with high efficiency and reliability in low temperature environments...



The earth's surface acts as a huge solar collector, absorbing radiation from the sun. In the UK, the ground maintains a constant temperature of $11\text{-}13^{\circ}\text{C}$ several metres below the surface all the year around. Among many other alternative energy resources and new potential technologies, the ground source heat pumps (GSHPs) are receiving increasing interest because of their potential to reduce primary energy consumption and thus reduce emissions of greenhouse gases.

Direct expansion GSHPs are well suited to space heating and cooling and can produce significant reduction in carbon emissions. In the vast majority of systems, space cooling has not been normally considered, and this leaves ground-source heat pumps with some economic constraints, as they are not fully utilised throughout the year. The tools that are currently available for design of a GSHP system require the use of key site-specific parameters such as temperature gradient and the thermal and geotechnical properties of the local area. A main core with several channels will be able to handle heating and cooling simultaneously, provided that the channels to some extent are thermally insulated and can be operated independently as single units, but at the same time function as integral parts of the entire core. Loading of the core is done by diverting warm and cold air from the heat pump through the core

during periods of excess capacity compared to the current needs of the building. The cold section of the core can also be loaded directly with air during the night, especially in spring and fall when nighttimes are cooler and daytimes are warmer. The shapes and numbers of the internal channels and the optimum configuration will obviously depend on the operating characteristics of each installation. Efficiency of a GSHP system is generally much greater than that of the conventional air-source heat pump systems. Higher COP (coefficient of performance) is achieved by a GSHP because the source/sink earth temperature is relatively constant compared to air temperatures. Additionally, heat is absorbed and rejected through water, which is a more desirable heat transfer medium due to its relatively high heat capacity.

The GSHPs in some homes also provide:

- Radiant floor heating.
- Heating tubes in roads or footpaths to melt snow in the winter.
- Hot water for outside hot tubs and
- Energy to heat hot water.

With the improvement of people's living standards and the development of economies, heat pumps have become widely used for air conditioning. The driver to this was that environmental problems associated with the use of refrigeration equipment, the ozone layer depletion and global warming are increasingly becoming the main concerns in developed and developing countries alike. With development and enlargement of the cities in cold regions, the conventional heating methods can severely pollute the environment. In order to clean the cities, the governments drew many measures to restrict citizen heating by burning coal and oil and encourage them to use electric or gas-burning heating. New approaches are being studied and solar-assisted reversible absorption heat pump for small power applications using water-ammonia is under development.

An air-source heat pump is convenient to use and so it is a better method for electric heating. The ambient temperature in winter is comparatively high in most regions, so heat pumps with high efficiency can satisfy their heating requirement. On the other hand, a conventional heat pump is unable to meet the heating requirement in severely cold regions anyway, because its heating capacity decreases rapidly when ambient temperature is below -10°C . According to the weather data in cold regions, the air-source heat pump for heating applications must operate for long times with high efficiency and reliability when ambient temperature is as low as -15°C . Hence, much researches and developments has been conducted to enable heat pumps to operate

steadily with high efficiency and reliability in low temperature environments. For example, the burner of a room air conditioner, which uses kerosene, was developed to improve the performance in low outside temperature. Similarly, the packaged heat pump with variable frequency scroll compressor was developed to realise high temperature air supply and high capacity even under the low ambient temperature of -10 to -20°C . Such a heat pump systems can be conveniently used for heating in cold regions. However, the importance of targeting the low capacity range is clear if one has in mind that the air conditioning units below 10 kW cooling account for more than 90% of the total number of units installed in the EU.

Methods and Laboratory Measurements

This communication describes the details of the prototype GSHP test rig, details of the construction and installation of the heat pump, heat exchanger, heat injection fan and water supply system. It also, presents a discussion of the experimental tests being carried out.

Main Experimental Test Rig

The schematic of the test rig that was used to support the two ground-loop heat exchangers is shown in Figure 1. It consisted of two main loops: heat source loop and evaporation heat pump. Three boreholes were drilled each 30 meters deep to provide sufficient energy. The closed-loop systems were laid and installed in a vertical well. The ground-loop heat exchangers were connected to the heat pump.

Direct Expansion Heat Pump Installation

The experimental work undertaken was separated into three parts. The first part dealt with drilling three boreholes each 30 meter deep, digging out the pit and connection of the manifolds and preparation of coils. Holes were grouted with bentonite and sand. The pipes were laid and tested with nitrogen. Then, the pit was backfilled and the heat pump was installed. The second part was concerned with the setting up of the main experimental rig: construction and installation of the heat injection fan, water pump, expansion valve, flow meter, electricity supply, heat exchanger and heat pump. The third part was an installation of refrigerator and measurements.

The aim of this project is to present and develop a GSHP system to provide heating and cooling for buildings (Figure 2). The heat source loop consisted of two earth loops: one for vapour and one for liquid. A refrigeration application is only concerned with the low temperature effect produced at the evaporator; while a heat pump is also concerned with the heating effect produced at the condenser.

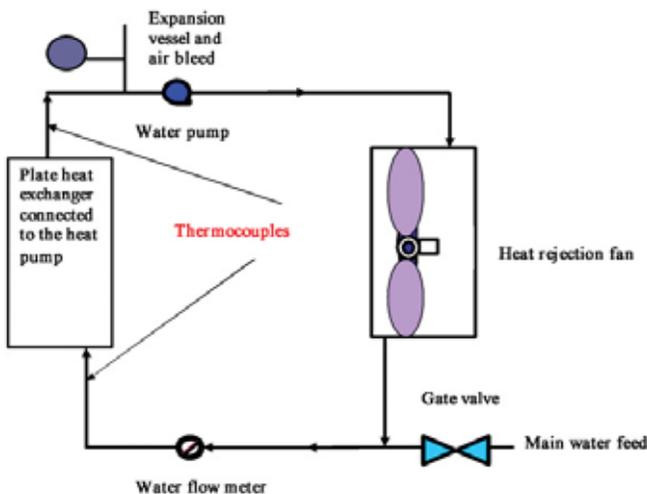


Figure 1: Sketch of installing heat pump...

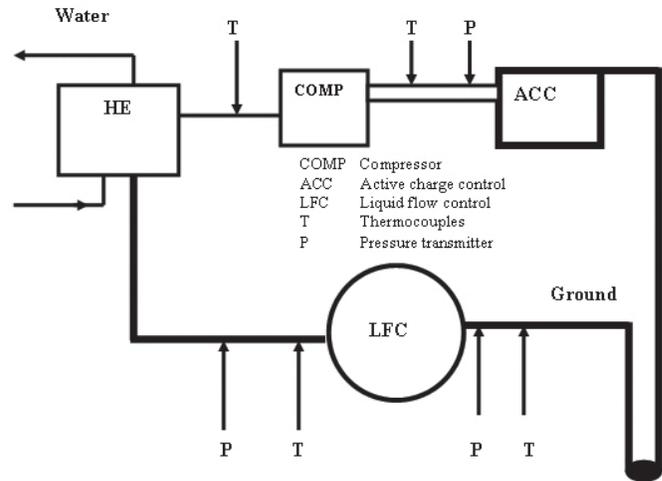


Figure 2: Shows the connections of ground loops to heat pump and heat exchanger...

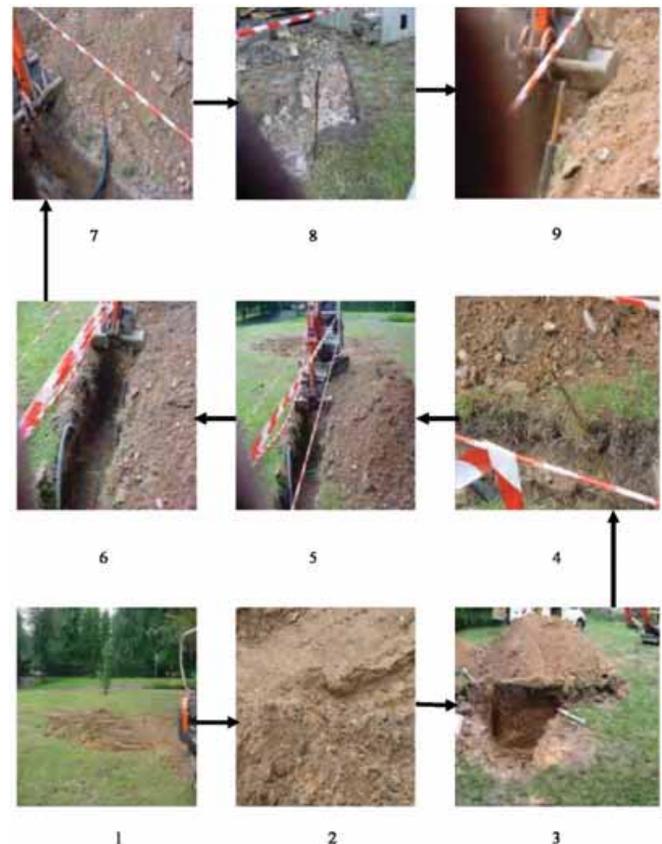


Figure 3. Showing the drilling (1-2) digging of the pit (3), connection of the manifolds (4), grouting, preparation of the coils (5-6) and the source loop, which consists of two earth loops: one for vapour and one for liquid (7-9)...

The earth-energy systems, EESs, have two parts; a circuit of underground piping outside the house, and a heat pump unit inside the house. And unlike the air-source heat pump, where one heat exchanger (and frequently the compressor) is located outside, the entire GSHP unit for the EES is located inside the house.

The outdoor piping system can be either an open system or closed loop. An open system takes advantage of the heat retained in an underground body of water. The water is drawn up through a well directly

to the heat exchanger, where its heat is extracted. The water is discharged either to an aboveground body of water, such as a stream or pond, or back to the underground water body through a separate well. Closed-loop systems, on the other hand, collect heat from the ground by means of a continuous loop of piping buried underground. An antifreeze solution (or refrigerant in the case of a DX earth-energy system), which has been chilled by the heat pump's refrigeration system to several degrees colder than the outside soil, and circulates through the piping, absorbing heat from the surrounding soil.

The direct expansion (DX) GSHP installed for this study was designed taking into account the local meteorological and geological conditions. The site was at the School of the Built Environment, University of Nottingham, where the demonstration and performance monitoring efforts were undertaken Figures (3-4). The heat pump has been fitted and monitored for one-year period. The study involved development of a design and simulation tool for modelling the performance of the cooling system, which acts a supplemental heat rejecting system using a closed-loop GSHP system. With the help of the Jackson Refrigeration (Refrigeration and Air Conditioning engineers) the following were carried out:

- Connection of the ground loops to the heat pump
- Connection of the heat pump to the heat exchanger
- Vacuum on the system
- Charging the refrigeration loop with R407C refrigerant

Water Supply System

The water supply system consisted of water pump, boiler, water tank, expansion and valve flow metre (Figure 4). A thermostatically controlled water heater supplied warm water, which was circulated between the warm water supply tank and warm water storage tank using a pump to keep the surface temperature of the trenches at a desired level.



Figure 4: Showing preparation of coils (1-2), installation of heat pump (3-6) and connection of water supply system (water pump, flow metre, expansion valve and the boiler) (7-9)...

The ground source heat pump system, which uses a ground source with a smaller annual temperature variation for heating and cooling systems, has increasingly attracted market attention due to lower expenses to mine for installing underground heat absorption pipes and lower costs of dedicated heat pumps, supported by environmentally oriented policies. The theme undertakes an evaluation of heat absorption properties in the soil and carries out a performance test for a DX heat pump and a simulated operation test for the system. In fact, these policies are necessary for identifying operational performance suitable for heating and cooling, in order to obtain technical data on the heat pump system for its dissemination and maintain the system in an effort of electrification. In these circumstances, the study estimated the heat properties of the soil in the city of Nottingham and measured thermal conductivity for the soil at some points in this city, aimed at identifying applicable areas for ground source heat pump system.

Design and Installation

Installation of the heat pump system and especially the ground heat exchanger needs to be carefully programmed so that it does not interfere with or delay any other construction activities. The time for installation depends on soil conditions, length of pipe, equipment required and weather conditions. The DX systems are most suitable for smaller domestic applications.

The most important first step in the design of a GSHP installation is accurate calculation of the building's heat loss, its related energy consumption profile and the domestic hot water requirements. This will allow accurate sizing of the heat pump system. This is particularly important because the capital cost of a GSHP system is generally higher than for alternative conventional systems and economies of scale are more limited. Oversizing will significantly increase the installed cost for little operational saving and will mean that the period of operation under part load is increased. Frequent cycling reduces equipment life and operating efficiency. Conversely if the system is undersized design conditions may not be met and the use of top-up heating, usually direct acting electric heating, will reduce the overall system efficiency. In order to determine the length of heat exchanger needed to piping material. The piping material used affects life; maintenance costs, pumping energy, capital cost and heat pump performance.

Heat Pump Performance

The need for alternative low-cost energy resources has given rise to the development of the DX-GSHPs for space cooling and heating. The performance of the heat pump depends on the performance of the ground loop and vice versa. It is therefore essential to design them together. Closed-loop GSHP systems will not normally require permissions/authorisations from the environment agencies. However, the agency can provide comment on proposed schemes with a view to reducing the risk of groundwater pollution or derogation that might result. The main concerns are:

- Risk of the underground pipes/boreholes creating undesirable hydraulic connections between different water bearing strata.
- Undesirable temperature changes in the aquifer that may result from the operation of a GSHP.
- Pollution of groundwater that might occur from leakage of additive chemicals used in the system.

Efficiencies for the GSHPs can be high because the ground maintains a relatively stable temperature allowing the heat pump to operate close to its optimal design point. Efficiencies are inherently higher than for air source heat pumps because the air temperature varies both throughout

the day and seasonally such that air temperatures, and therefore efficiencies, are lowest at times of peak heating demand.

A heat pump is a device for removing heat from one place - the 'source' - and transferring it at a higher temperature to another place. The heat pumps consist of a compressor, a pressure release valve, a circuit containing fluid (refrigerant), and a pump to drive the fluid around the circuit. When the fluid passes through the compressor it increases in temperature. This heat is then given off by the circuit while the pressure is maintained. When the fluid passes through the relief valve the rapid drop in pressure results in a cooling of the fluid. The fluid then absorbs heat from the surroundings before being re-compressed. In the case of domestic heating the pressurised circuit provides the heating within the dwelling. The depressurised component is external and, in the case of ground source heat pumps, is buried in the ground. Heat pump efficiencies improve as the temperature differential between 'source' and demand temperature decreases, and when the system can be 'optimised' for a particular situation. The relatively stable ground temperatures moderate the differential at times of peak heat demand and provide a good basis for optimisation.

The refrigerant circulated directly through the ground heat exchanger in a direct expansion (DX) system but most commonly GSHPs are indirect systems, where a water/antifreeze solution circulates through the ground loop and energy is transferred to or from the heat pump refrigerant circuit via a heat exchanger. This application will only consider closed loop systems. The provision of cooling, however, will result in increased energy consumption and the efficiently it is supplied. The GSHPs are particularly suitable for new build as the technology is most efficient when used to supply low temperature distribution systems such as underfloor heating. They can also be used for retrofit especially in conjunction with measures to reduce heat demand. They can be particularly cost effective in areas where mains gas is not available or for developments where there is an advantage in simplifying the infrastructure provided.

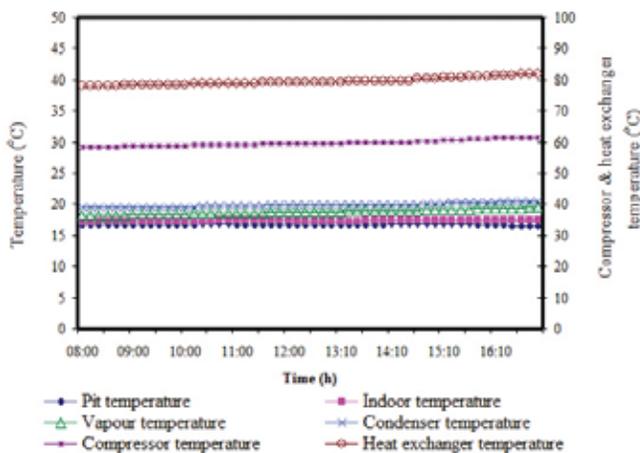


Figure 5: Variation of temperatures per day for the DX system

Coefficient of Performance (COP)

Heat pump technology can be used for heating only, or for cooling only, or be 'reversible' and used for heating and cooling depending on the demand. Reversible heat pumps generally have lower COPs than heating only heat pumps. They will, therefore, result in higher running costs and emissions. Several tools are available to measure heat pump performance. The heat delivered by the heat pump is theoretically the sum of the heat extracted from the heat source and the energy needed to deliver the

cycle. Figure 5 shows the variations of temperature with the system operation hours. Several tools are available to measure heat pump performance. The heat delivered by the heat pump is theoretically the sum of the heat extracted from the heat source and the energy needed to derive the cycle. For electrically driven heat pumps the steady state performance at a given set of temperatures is referred to as the coefficient of performance (COP). It is defined as the ratio of the heat delivered by the heat pump and the electricity supplied to the compressor:

$$COP = \frac{[\text{heat output (kW}_{th})]}{[\text{electricity input (kW}_{el})]} \quad (1)$$

For an ideal heat pump the COP is determined solely by the condensation temperature and the temperature lift:

$$COP = \frac{[\text{condensing temperature (}^{\circ}\text{C)}]}{[\text{temperature lift (}^{\circ}\text{C)}]} \quad (2)$$

Figure 6 shows the COP of heat pump as a function of the evaporation temperature. Figure 7 shows the COP of heat pump as a function of the condensation temperature. As can be seen the theoretical efficiency is strongly dependent on the temperature lift. It is important not only to have as high a source temperature as possible but also to keep the sink temperature (i.e., heating distribution temperature) as low as possible. The achievable heat pump efficiency is lower than the ideal efficiency because of losses during the transportation of heat from the source to the evaporator and from the condenser to the room and the compressor. Technological developments are steadily improving the performance of the heat pumps.

The need for alternative low-cost energy has given rise to the development of the GSHP systems for space cooling and heating in residential and commercial buildings. The GSHP systems work with the environment to provide clean, efficient and energy-saving heating and cooling the year round. The GSHP systems use less energy than alternative heating and cooling systems, helping to conserve the natural resources. The GSHP systems do not need large cooling towers and their running costs are lower than conventional heating and air-conditioning systems. As a result, GSHP systems have increasingly been used for building heating and cooling with an annual rate of increase of 10% in recent years. While in some zones such as hot summer and cold winter areas, there is a major difference between heating load in winter and cooling load in summer. Thus the soil temperature increases gradually after yearly operation of the GSHP system because of the inefficient recovery of soil temperature as the result of imbalance loads (Figure 8). Finally, the increase of soil temperature will decrease the COP of the system.

The first law of thermodynamics is often called the law of conservation of energy. Based on the first law or the law of conservation of energy for any system, open or closed, there is an energy balance as:

$$[\text{Net amount of energy added to system}] = [\text{Net increase of stored energy in system}] \quad (3)$$

or

$$[\text{Energy in}] - [\text{Energy out}] = [\text{Increased of stored energy in system}] \quad (4)$$

In a cycle, the reduction of work produced by a power cycle (or the increase in work required by a refrigeration cycle) equals the absolute ambient temperature multiplied by the sum of irreversibilities in all processes in the cycle. Thus, the difference in reversible and actual work for any refrigeration cycle, theoretical or real, operating under the same conditions becomes:

$$W_{\text{actual}} = W_{\text{reversible}} + T_0 \sum I \quad (5)$$

Where:

I is the irreversibility rate, kW/K.

T₀ is the absolute ambient temperature, K

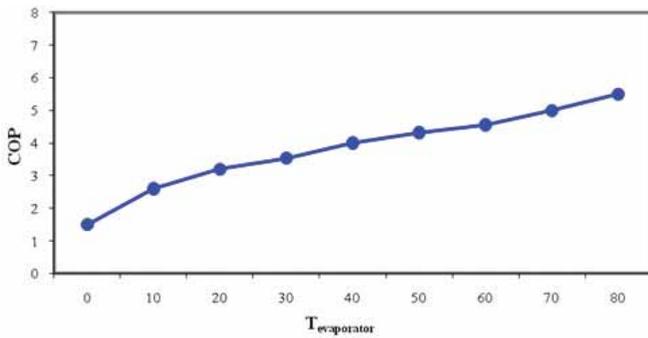


Figure 6: Heat pump performance vs evaporation temperature...

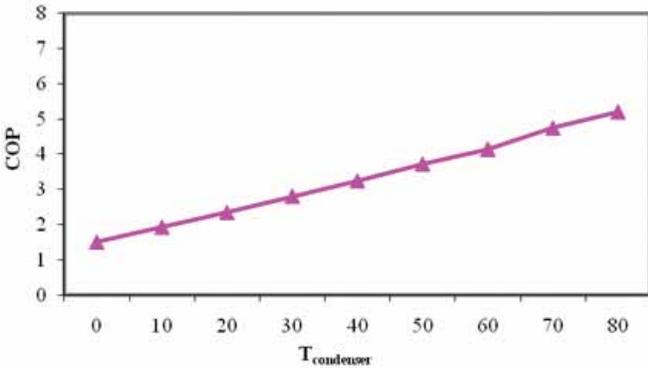


Figure 7: Heat pump performance vs condensation temperature...

Refrigeration cycles transfer thermal energy from a region of low temperature to one of higher temperature. Usually the higher temperature heat sink is the ambient air or cooling water, at temperature T_0 , the temperature of the surroundings. Performance of a refrigeration cycle is usually described by a coefficient of performance (COP), defined as the benefit of the cycle (amount of heat removed) divided by the required energy input to operate the cycle:

$$COP = \frac{[\text{Useful refrigeration effect}]}{[\text{Net energy supplied from external sources}]} \quad (6)$$

For a mechanical vapour compression system, the net energy supplied is usually in the form of work, mechanical or electrical and may include work to the compressor and fans or pumps. Thus,

$$COP = \frac{[Q_{evap}]}{[W_{net}]} \quad (7)$$

In an absorption refrigeration cycle, the net energy supplied is usually in the form of heat into the generator and work into the pumps and fans, or:

$$COP = \frac{(Q_{evap})}{(Q_{gen} + W_{net})} \quad (8)$$

In many cases, work supplied to an absorption system is very small compared to the amount of heat supplied to the generator, so the work term is often neglected. Applying the second law of thermodynamic to an entire refrigeration cycle shows that a completely reversible cycle operating under the same conditions has the maximum possible COP. Table 1 lists the measured and computed thermodynamic properties of the refrigerant. Departure of the actual cycle from an ideal reversible cycle is given by the refrigerating efficiency:

$$\eta_r = COP / (COP)_{rev} \quad (9)$$

Seasonal Performance Factor (SPF)

There are primary two factors to describe the efficiency of heat pumps. First, the coefficient of performance (COP) is determined in the test stand with standard conditions for a certain operating point and/or for a number of typical operating points. Second, the seasonal

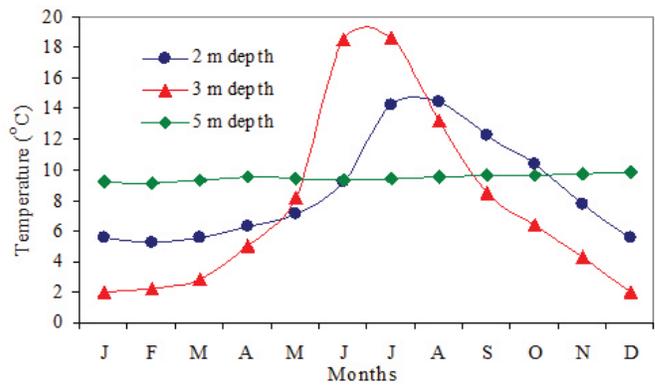


Figure 8: Seasonal temperature variations...

performance factor (SPF), describes the efficiency of the heat pump system under real conditions during a certain period, for example for one year. The SPFs in this case are the ratio of the heat energy produced by the heat pump and the back-up heater and the corresponding energy required of the heat pump. The SPF for individual months and an average value for the year 2008 for the DX GSHP are shown in Figure 9. The assessment of the 2008 measurement data for the GSHP in the buildings providing both heating and cooling reveals a seasonal performance factor (SPF) of 3.8. The SPF of the individual system was in the range of 3.0-4.6.

The preliminary results show that the GSHP are especially promising when it comes to reaching high efficiencies under real conditions. However, there is still a need for optimisation in the integration of the unit in the supply system for the house and for the control strategies of the heat pump. Thus, a poorly integrated heat source or an incorrectly designed heat sink can decrease the seasonal performance factor of the heat pump. The main point to consider is the careful layout of the system as a whole, rather than with respect to single components. High installation costs have been identified as a major barrier to wider application of the GSHPs often referred to as geothermal heat pumps. The primary reason cited for higher cost is the ground loop. Other factors may be high costs of the GSHP heat pump units and supplies, interior installation, and limited competition. The ground-source machine had lower demand (summer and winter) and lower heating energy use than either of the air heat pumps. Comparisons with natural gas must be based on cost since the units for natural gas (therm = 100,000 Btu) are different than electrical energy unit (kWh).

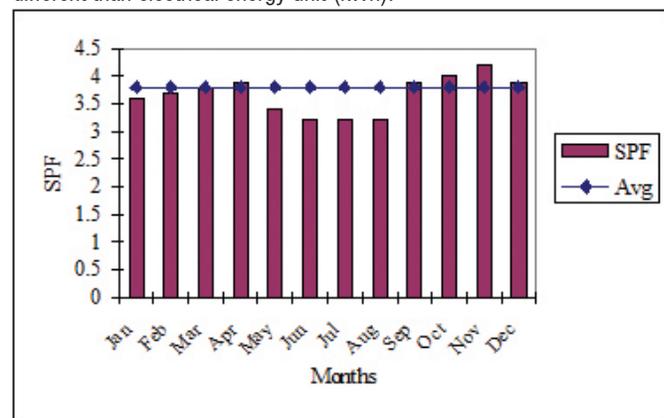


Figure 9: Seasonal performance for individual months and average for 2008...

Table 1: Measured and computed thermodynamic properties of R-22

Measured			Computed		
State	Pressure (kPa)	Temperature (°C)	Specific enthalpy (kJ/kg)	Specific entropy (kJ/kg°K)	Specific volume (m³/kg)
1	310	-10	402.08	1.78	0.075
2	304	-4	406.25	1.79	0.079
3	1450	82	454.20	1.81	0.021
4	1435	70	444.31	1.78	0.019
5	1410	34	241.40	1.14	0.0008
6	1405	33	240.13	1.13	0.0008
7	320	-12.8	240.13	1.15	0.0191

Comparison of Numerical Simulation and Experiments

The GSHPs are generally more expensive to develop, however they have very low operating cost, and justify the higher initial cost. Therefore, it is necessary to have an idea of the energy use and demand of these equipments. The performances are normally rated at a single fluid temperature (0°C) for heating COP and a second for cooling EER (25°C). These ratings reflect temperatures for an assumed location and ground heat exchanger type, and are not ideal indicators of energy use. This problem is compounded by the nature of ratings for conventional equipment. The complexity and many assumptions used in the procedures to calculate the seasonal efficiency for air-conditioners, furnaces, and heat pumps (SEER, AFUE, and HSPF) make it difficult to compare energy use with equipment rated under different standards. The accuracy of the results is highly uncertain, even when corrected for regional weather patterns. These values are not indicators for demand since they are seasonal

averages and performance at severe conditions is not heavily weighted.

The American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) recommends a weather driven energy calculation, like the bin method, in preference to single measure methods like seasonal energy efficiency ratio (SEER), seasonal performance factor (SPF), energy efficiency rating (EER), coefficient of performance (COP annual fuel utilisation efficiency rating (AFUE), and heating season performance factor (HSPF). The bin method permits the energy use to be calculated based on local weather data and equipment performance over a wide range of temperatures. Both solid and liquid parts co-existed in one control volume of non-isothermal groundwater flow. It was therefore necessary to integrate the two parts into one energy equation. Accordingly, the governing equation describing non-isothermal groundwater flow in a saturated porous medium was as follows:

$$T (\Delta v) + (\delta T / \delta t) \sigma = \alpha_t \Delta^2 T + q_t / (\rho C_p)_t \tag{10}$$

$$(\rho C_p)_t = \psi (\rho C_p)_i + (1 - \psi) (\rho C_p)_s \tag{11}$$

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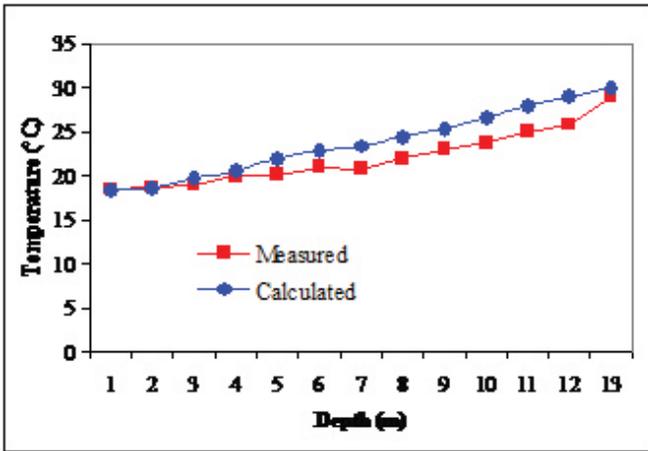


Figure 10: Comparison of calculations and experiments for saturated soil with groundwater flow (SSG)...

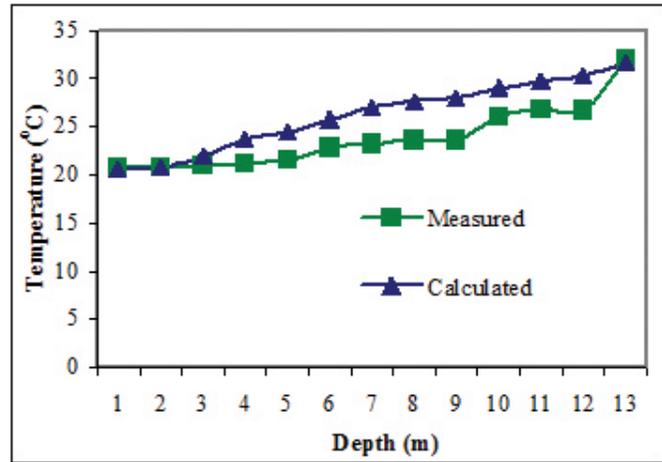


Figure 11: Comparison of calculations and experiments for saturated soil without groundwater flow (SS)...

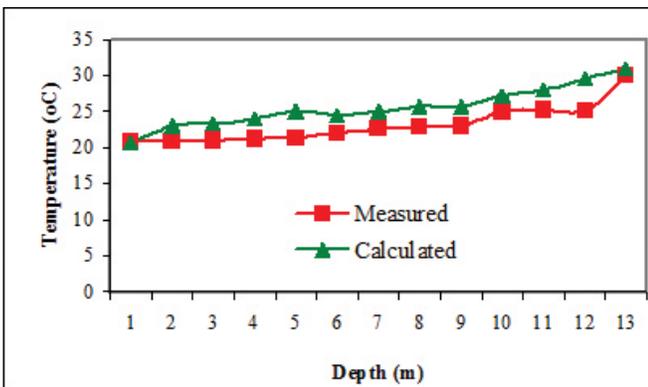


Figure 12: Comparison of calculations and experiments for unsaturated soil without groundwater flow (US)...

Conclusion

The direct expansion (DX) ground source heat pump (GSHP) systems have been identified as one of the best sustainable energy technologies for space heating and cooling in residential and commercial buildings. The GSHPs for building heating and cooling are extendable to more comprehensive applications and can be combined with the ground heat exchanger in foundation piles as well as seasonal thermal energy storage from solar thermal collectors. Heat pump technology can be used for heating only, or for cooling only, or be 'reversible' and used for heating and cooling depending on the demand. Reversible heat pumps generally have lower COPs than heating only heat pumps. They will, therefore, result in higher running costs and emissions and are not recommended as an energy-efficient heating option. The GSHP system can provide 91.7% of the total heating requirement of the building and 55.3% of the domestic water-heating requirement, although only sized to meet half the design-heating load. The heat pump can operate reliably and its performance appears to be at least as good as its specification. The system has a measured annual performance factor of 3.16. The heat pump system for domestic applications could be mounted in a cupboard under the stairs and does not reduce the useful space in the house, and there are no visible signs of the installation externally (no flue, vents, etc.).

The performance of the heat pump system could also be improved by eliminating unnecessary running of the integral distribution pump. It is estimated that reducing the running time of the pump, which currently runs virtually continuously, would increase the overall performance factor to 3.43.

This would improve both the economics and the environmental performance of the system. More generally, there is still potential for improvement in the performance of heat pumps, and seasonal efficiencies for ground source heat pumps of 4.0 are being achieved. It is also likely the unit costs will fall as production volumes increase. By comparison, there is little scope to further improve the efficiency of gas- or oil-fired boilers. ■

Latent heat during phase changes between freezing soil and thawing soil was regarded as an inner heat source described as follows:

$$WH (\sigma_d) \delta f_s / \delta t_s = q_s \tag{12}$$

$$(\delta T / \delta t) \sigma + U_x \delta T_f / \delta x = \alpha_f \Delta^2 T + qt / (\rho C_p)_f \tag{13}$$

Where:

C_p is the specific heat ($J kg^{-1} K^{-1}$); q is the internal heat source (Wm^{-3}).

W is the water content in soil (%); T is the temperature ($^{\circ}C$).

H is the condensation latent heat of water ($J kg^{-1}$).

t is the times (s); U is the velocity (ms^{-1}).

f_s is the solid phase ratio.

s is the soil; f is the groundwater.

Ψ is the porosity.

α is the convective heat transfer coefficient ($Wm^{-2}K^{-1}$).

δ is volumetric specific heat ratio.

ρ is the density ($kg m^{-3}$).

The experiments and calculations are conducted for unsaturated soil without groundwater flow (US), saturated soil without groundwater flow (SS) and saturated soil with groundwater flow (SSG) under same conditions and their results are compared with each other in Figures 10-12. The temperature in vertical boreholes used, as heat source for GSHPs will slowly drop with time, the more so the more energy is extracted. This can be mitigated either by a deeper borehole (in a new installation) or a system to replenish the energy extracted from the hole (in both new and existing installations). Raising the brine temperature from $-5^{\circ}C$ to $0^{\circ}C$ may improve the COP by 10-50% depending on the type of heat pump.

Abdeen Mustafa Omer
Energy Research Institute (ERI)
Nottingham, UK



Reducing

The Heat Transfer

'INSUshield' is a non-fibrous, fire retardant, closed cell, tri dimensional chemically cross-linked polyethylene foam XLPE...

The radiant heat is invisible and has no temperature, just energy. When this energy strikes another surface, it is absorbed and increases the temperature of that surface. In summer, radiation from the sun strikes the outer surfaces of walls and ceilings and is absorbed causing the surface to heat up. This heat flows from the outer wall to the inner wall through conduction which is then radiated again, through the air spaces in the building, to other surfaces within the building. Radiation between surfaces is through invisible, infra-red heat rays.

Different types of insulation products reduce the heat transferred by conduction, convection and radiation to varying degrees. As a result, each provides different thermal performance and corresponding 'R' values. The primary function of reflective insulation is to reduce radiant heat transfer across open spaces, which is a significant contributor to heat gain in summer and heat loss in winter.

There are many types of materials that reduce heat gain and heat loss.

Some materials provide greater resistance than others, depending on the mode of heat transfer: convection, conduction or radiation. Most insulation materials work on the principle of trapped air gas being a good insulator. Mass insulation like, 'INSUshield'- closed cell, FR crosslinked polyethylene foam, use cellular walls of plastics, Fibre glass wool uses glass fibres to reduce convection thereby decreasing the transfer of heat.

These materials also reduce heat transfer by conduction due to the presence of trapped air. (However, these products, like most building materials, have very high radiant transfer rates. Most building materials, including fibreglass, foam and cellulose have 'E' values in excess of 0.70.

Reflective insulations typically have 'E' values of 0.03 (again, the lower the better). Therefore, reflective insulation is superior to other types of insulating materials in reducing heat flow by radiation. When reflective insulation is installed in building cavities, it traps air (like other insulation materials), and therefore reduces heat flow by convection thus addressing all three modes of heat transfer.



Application of INSUreflector – underdeck insulation...

In all cases, the reflective material must be adjacent to an air space. Aluminium, when sandwiched between two pieces of plywood or between two concrete layers for example, will conduct heat at a high rate. The conductive insulation material should always be in contact with the substrate for better insulation.

Understanding a Reflective Insulation System (RIS)

A reflective insulation system is typically formed by layers of aluminium or a low emittance material and enclosed air spaces which in turn provide highly reflective or low emittance cavities (Air bubble film) adjacent to a heated region.

The performance of the system is determined by the emittance of the material(s), the lower the better, and the size of the enclosed air spaces. The smaller the air space, the less heat will transfer by convection. Therefore, to lessen heat flow by convection, a reflective insulation, with its multiple layers of aluminium and enclosed air space(INSUreflector), is



A view of the plant site using INSUreflector...

positioned in a building cavity (stud wall, furred-out masonry wall, floor joist, ceiling joist, etc.) to divide the larger cavity (3/4" furring, 2" x 4", 2" x 6", etc.) into smaller air spaces. These smaller trapped air spaces reduce convective heat flow.

Reflective Insulation Differs from Conventional Mass Insulation in the Following Ways

1. Reflective insulation has very low emittance values 'E-values' (typically 0.03 compared to 0.90 for most insulation) thus significantly reduces heat transfer by radiation
2. A reflective insulation does not have significant mass to absorb and retain heat
3. Reflective insulation has lower moisture transfer and absorption rates, in most cases
4. Reflective insulation traps air with layers of aluminium & air bubble film plastic as opposed to mass insulation that uses fibres of glass, particles of foam, or ground up paper

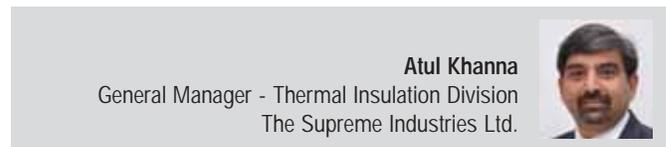
5. Reflective insulation does not irritate the skin, eyes, or throat and contain no substances, which will out-gas
6. The change in thermal performance due to compaction or moisture absorption, a common concern with mass insulation, is not an issue with reflective insulation.

Supreme's Thermal Insulation Division Offers Solutions in the Following Areas

1. Ducting insulation in hospitals, shopping malls, airports, PEBS, IT/ BPO etc.
2. Pipe insulation for split AC tubings, chiller piping, drain pipes, chilled water lines etc.
3. Floor insulation in server rooms, data centres, medical and diagnostic centres, and control rooms for petrochemicals.
4. Underdeck insulation in PEBS, textile units, malls, airports etc.
5. Overdeck and wall insulation in commercial buildings, residential buildings, cold storages etc.

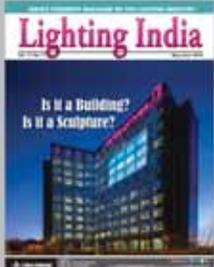
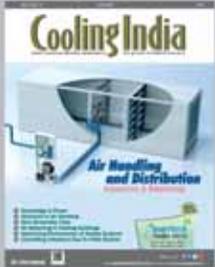
'INSUreflector' offered by Supreme is made of polyethylene Air Bubble Film (ABF) laminated with aluminium foil on one or both sides. The bright surface of the aluminium foil reflects 96 to 99% infra-red radiation received by the surface of a heated slate roof. It protects the building from undesirable heat gain. The thin reflective foil having low emissivity and high reflectivity when installed with an air space restricts the transfer of far-infrared radiation making it an ideal material to be used for underdeck application.

'INSUshield' is a non-fibrous, fire retardant, closed cell, tri dimensional chemically cross-linked polyethylene foam XLPE. An ideal environment friendly insulation material, with a perfect solution for all your insulation needs for ducts, roofs, pipes, vessels, etc. The divergent advantages of 'INSUshield' are ease of installation, low thermal conductivity and good moisture and vapour resistance preventing microbial growth and optimum condensation protection. ■



Atul Khanna
General Manager - Thermal Insulation Division
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India Cold Chain Show 2016 Closed On Exceedingly High Note

Once again the show saw an impressive line-up of international and national companies from various sectors such as horticulture, material handling, humidifier & dehumidifiers, freezing and chilling systems, air curtains, cold storage doors, compressors, packaging and others. These sectors cater to Horticulture, Pharma, FMCG, Seed, Seafood, Chemicals, Frozen products, Processed Foods etc...



The show was inaugurated by Dr. A. K. Sharma, Managing Director, National Horticulture Board along with several dignitaries from APEDA, NCCD and Cold Storage Federation of India...

India's premier event on cold chain industry, the 5th India Cold Chain Show 2016 concluded on 17-18-19 October 2016 at Bombay Exhibition Centre in Mumbai having exceeded expectations in attracting a turnout 6,986 high quality trade visitors with 80% top management and decision makers, 150+ conference delegates and 144 exhibitors from more than 6 countries.

Once again the show saw an impressive line-up of international and national companies from various sectors such as horticulture, material handling, humidifier & dehumidifiers, freezing and chilling systems, air curtains, cold storage doors, compressors, packaging and others.

These sectors cater to Horticulture, Pharma, FMCG, Seed, Seafood, Chemicals, Frozen products, Processed Foods etc. The show also had two new pavilions – China and Holland respectively. Representing a 35% increase in exhibitor participation compared to 2015, this annual exhibition received a positive and outstanding feedback for attracting a relevant and targeted audience from cold chain industry from private and public sectors.

As stated by Anuj Mathur, Managing Director, Reed Manch Exhibitions, "India Cold Chain 2016 presented a comprehensive range of equipment, machinery, services and solutions catering to the needs of domestic and international audience. In fact, visitor number grew by 39%



Business enquiries continued in full swing in the India Cold Chain Show 2016...



compared to the last edition. This growth is a clear testament to the relevance of the exhibition and demand of Cold Storage Infrastructure, IT solutions for Cold Storage, Material Handling Solutions and Supply Chain in the region."

Global Showcase of New Technologies

The only event dedicated to cold chain sector, India Cold Chain is incontestably the show that showcase new products and technologies. Tata Motors, the largest manufacturers in Indian automotive industry has launched its Reefer and Mini Trucks for the first time in any exhibition.

These trucks are custom made for transportation of perishable frozen foods such as ice cream, fisheries, dairy products, meat and pharmaceuticals. Similarly, many companies such as Yes Bank, knowledge partner of the show launched a white paper on 'Innovations in Cold Chain – The Dairy Value Chain Perspective.'

This will help to initiate a seamless exchange of knowledge amongst stakeholders involved in the dairy cold chain domain including the industry as well as policy makers. Ideal Fogging System, Kahan Controls, Isuzu were some of the other names that also launched their products in the show.

Content Rich in Information

India Cold Chain took place once again concurrently with thought-provoking India Cold Chain Conference on the theme 'Taking Cold Chain Business to Next Level: Opportunities & Challenges' on 17-18 October



The thought-provoking India Cold Chain Conference was attended by many fore-runners of the industry...

2016. It was inaugurated by Dr. A. K. Sharma, Managing Director, National Horticulture Board along with several dignitaries from APEDA, NCCD and Cold Storage Federation of India. Leading speakers from, ColdStar Logistics, Danfoss Industries, Warehousing Development Regulatory Authority, Dulas Ltd. UK, Kool-Ex Cold Chain, GATI, etc., were also present during the conference.

The conference placed the emphasis on the underlying trends on cold chain market such as latest innovations, digital revolution, techniques etc. More than 150 conference delegates came to the conference: yet another record!

Success Year-on-Year

As per the exhibitors, India has become one of the important markets in Asia. They see a great future here, which is why they exhibited in India Cold Chain 2016. Professional B2B meetings were arranged to exhibitors related to their sectors by match-making system. Close to 86% of exhibitors are likely to return to exhibit at India Cold Chain 2017.

Mathur further stated, "The show and conference came at a time when GST bill implemented on overall service sectors. There is a complementarity between India Cold Chain show and India Cold Chain Conference bringing together the full gamut of know-how and expertise in the field of cold chain sector attracting national and international brands. This year there were more visitors and this observation becomes more pertinent year-on-year. It shows that it is a genuine platform for all cold chain professionals in the region. Once again thanks to your collaboration and support that the exhibition exceeded expectations."



More than 150 conference delegates came to the conference...

Glimpses of Stalls



The next edition of India Cold Chain Show 2017 will be held in Bombay Exhibition Centre, Mumbai, from 12 to 14th December, 2017...

CHILLVENTA

Delivers Its Promises

The Chillventa 2016 came to an end after three extraordinarily successful days with significant growth on the area and visitors. She presented herself again this year at her best. It came with 32 206 visitors, which is 5% more than that in 2014. Also, the Chillventa confirmed its excellent and stable number of exhibitors: 982 companies. Particularly impressive is the increase in space this year. On the day before the show, Chillventa CONGRESS became highly attractive to the professional world. Two hundred and sixty participants and speakers from 31 countries were impressed by the high-calibre programme and the first-class speakers from all over the world...

For the fifth time, Chillventa turned the exhibition halls in Nuremberg into the world's largest and most important international branch meeting for the refrigeration, air-conditioning, ventilation and heat pump community. "We are very satisfied with the Chillventa 2016. The event has once again grown significantly in the area and has brought more specialist visitors to Nuremberg. Nine hundred and eighty two companies from all over the world have visited 32,206 trade visitors. In the best sense, Chillventa Connecting Experts was held at the world's leading trade fair. Internationality on the exhibitor side is over two-thirds. Fifty six per cent of visitors from abroad are also an excellent commitment of the industry. This makes Chillventa one of the highly international events at NürnbergMesse," explains Richard Krowoza, Member of the Management Board, NürnbergMesse.

With its comprehensive and precise range of services tailored to the needs of the market participants, Chillventa provided a very good and deep insight into the industry with components, systems and applications for refrigeration, air conditioning, ventilation and heat pumps. The focus of this year's trade show, Chillventa CONGRESS and trade fairs were, amongst others, the current climate, ECO design, efficiency through regulation, innovation in heat transfer. The refrigerants played a central role as well.



Registration desk for Chillventa Congress...



Delegates are exchanging knowledge at Chillventa Congress...

Expertise for Experts: Chillventa CONGRESS

The slogan Chillventa Connecting Experts is not only practised at the Chillventa in the exhibition halls, but also at the specialist programme. Dr. Rainer Jakobs, Coordinator for Chillventa, had ensured that the experts at Chillventa CONGRESS would be provided with information at the highest level on the day before the fair, as well as in the forums of the exhibition halls.

The conference on the eve of the fair provided the 260 participants from 31 countries with extensive and highly valuable information. The international refrigeration sector discussed, among other things, climate change and climate policy, trends in household appliance refrigeration, organic Rankine cycle, EPEE Gapometer, Market Surveillance and high-temperature heat pumps, just to name a few.

Expertise in the Halls

In the specialist forums, more than 180 lectures were delivered on the current product developments, innovations and applications.

Energy efficiency, energy saving and refrigerant were discussed in Hall 9 (Applications, Training and Regulations), in Hall 7A Kältetechnik and in Forum Hall 4A, everything about climate, ventilation and heat pumps was shown. Numerous expert talks provided pure specialist knowledge and provided the opportunity to deepen and concentrate on individual topics.

The focus was on new refrigerant mixtures and their applications, safety aspects, cooling towers, hygienic and safe operation, Internet of Things (IoT) or R744 in the craft education. The high number of visitors to the forums showed great interest in these topics.

The International Branch Meeting for Visitors and Exhibitors

"The Chillventa with Chillventa CONGRESS and the Fachforen is one of the events at the Messeplatz Nürnberg with the highest internationality. Over the last few years, it has gained an international reputation both on the exhibitors' side as well as on the visitors' side. This year was also not an exception," said Daniela Heinkel, Event Manager, Chillventa.

New Ideal Carrier

Chillventa is now the platform where not only trade visitors and exhibiting companies meet and exchange their business talks, but also all major associations as well as journalists from Germany and abroad assemble here to get updates. As of this event, NürnbergMesse announces that the VDKF is a new and ideal carrier.

The Visitors are Very Satisfied with Their Chillventa

The importance of the fair also shows the high percentage of decision-makers. In fact, eight out of ten specialists visited directly, indirectly or in an advisory capacity in purchase and procurement processes. About 95% of the trade visitors were very satisfied. The great commitment of the industry is also reflected in the intention of 2018 to participate in the Chillventa. Nine out of ten were returning to visit the upcoming Chillventa.

Exhibitors Satisfied with the Chillventa 2016

The mood in the full exhibition halls of the Chillventa was again excellent this year. On the one hand, the trade visitors and the exhibiting companies were responsible. On both sides the right people met. This positive image also underpins the independent exhibitor survey. Ninety three per cent of the exhibiting companies stated that the event was a success for them. Around 94% were able to make new business contacts and nine out of ten expect a follow-up business. Eighty eight per cent exhibitors also confirmed to be exhibiting again in 2018 during the term.

Specialists' Presentations Convinced the Professional World

In addition to innovations on the stands of the exhibitors, the three special presentations on the topics of energy-efficient data centres,



Knowledge sharing is going on in the conference...

industrial and commercial heat pumps as well as the energetic inspection of air-conditioning and ventilation systems were convincing. The inflow was enormous and also underlined the idea: Chillventa Connecting Experts.

The Chillventa AWARD

The Chillventa AWARD celebrated its premiere in 2016. For the first time, NürnbergMesse and Bauverlag awarded the reward to the lucky winners. The Chillventa AWARD was launched in the categories of large-scale refrigeration, commercial refrigeration, air conditioning and heat pumps.



The Chillventa Award winners are standing together...

In judging the submissions, the jury took several aspects into account: following the Chillventa motto 'Connecting Experts', the planning and cooperation of those involved in the project were the first priority, followed by the criteria 'Implementation of the planning contract', 'Functionality', 'Innovation depth' As well as 'economy and operation'. The winners of the respective categories had to collect points in all areas.

The jury met in September and agreed: An outstanding planning for a 08/15 technique had just as few chances to win as a technically sophisticated project, in which the particular partnership-based cooperation was not transparent. The ultimately award-winning submissions clearly show that there are excellent cooling engineering plans and projects both with and without the use of natural refrigerants.

Winner in the United Refrigeration Category

Project: Ammonia refrigeration center for Paulaner brewery

A cooling center was planned and implemented for the construction of a brewery of the company Paulanerbrauerei GmbH & Co. KG in Munich Langwied. This included an ammonia refrigeration plant with screw compressors, evaporators with gravity circulation, evaporative condensers (10.8 MW), high-pressure collectors, economizers, separators and various consumer pumps. The system supplies an alcohol water system for tank storage and utility cooling



Discussions during Tea Break...



In the category Großkälte wins;
Project: Ammoniak-Kältezentrale for Paulaner Brewery...



In the heat pumps wins; Project:
Branch-house technology concept for dm markets...



Bringing victory in the category of Climatic Technology;
Project: Refrigeration - air conditioning for Rupp + ...

with 6.3 MW (temperature level -8°C) and a brewing water system with brew water storage for brewing water cooling at 2 MW (temperature level 0°C). It cools the tank storage, the storage tanks as well as several production processes and air-conditioning the production halls and the computer centre.

A pre-planning of the Heineken Supply Chain (planner) was revised and optimised by the Johnson Controls Service GmbH (responsible for execution and commissioning), which led the client Paulaner and the planner Heineken Supply Chain to plan the entire plant footprint. This concept now serves as a Blaupause for other breweries.

Contractors, planners, exporting companies and testing organizations worked very closely together, so that timely implementation could be adhered to within a given cost framework, accompanied by a continuous schedule and execution control. The plant concept takes particular account of the ease of use by the on-site personnel (e.g. operating hours of all drives to optimise service work, Johnson Controls' fault application to troubleshoot local problems, comprehensive visualisation and data recording). The construction management was permanently involved and was able to actively shape the project.

Winning Project in the Climatic Engineering Category

Project: Refrigeration and air conditioning for Rupp + Hubrach

Rupp + Hubrach, one of Germany's leading manufacturers of eyewear, requires process cold water for various production processes and air-conditioning. As one of a total of three refrigeration machines, a new plant of the company hekra Kälte- und Klimatechnik GmbH, which was installed as an exchange for an obsolete plant, now supplies the cold water network.

At Rupp + Hubrach the environmental protection concept at the Bamberg site is to be strengthened not only in the core process, the production of spectacle lenses. The company is also committed to the use of environmentally friendly technology in support processes, such as the supply of cooling water. The result of long-term performance calculations, an economic calculation and an in-depth examination of possible components of the new plant is a refrigeration machine with a rated output of 270 kW, equipped with a highly efficient, oil-free turbo refrigerant compressor. One technical challenge was the complete integration of the new plant engineering into the existing building control technology as well as the existing cold water network (plant hydraulics).

In addition to the operator's requirement to use environmentally friendly technology, greater energy efficiency and cost savings had to be planned in advance for the parent company. Therefore, great attention was paid to an accurate detection of the load situation. Within the framework of a master thesis, the system (load behavior under fluctuating production capacity) was analysed for several weeks – and a detailed evaluation of the results was carried out.

The contractor Rupp + Hubrach, the plant builder Hekra and all adjacent trades worked very closely together in the development of the plant concept. Other companies, such as Siemens (provider of the GLT) and company departments (Facility Management), were also closely involved, as the conversion had to be carried out with constant operation, a tight schedule and confined space in the technical area.

In Heat Pumps

Project: Branch-house technology concept for dm markets

At dm-drogerie markt, a standardized house technology concept for all dm markets was developed from 2008 to 2012 and has since then been implemented in 950 dm markets. The technology used enables simultaneous heating and cooling, without any energy losses, using a 3-wire system with heat recovery. The direct evaporation system used (air heat pump) requires 33% less electricity than separate systems for heating and cooling. Only green electricity is used to drive the heat pump.

Numerous room sensors and sensors record the current number of people in the market and continuously determine the thermal situation, including an intelligent control of the door air curtain with a specially developed automatic control system. An online energy management system evaluates all data automatically and visualizes it ('transparent' branch). All trades (heating, air-conditioning, and ventilation, light) communicate with each other, with particular emphasis being placed on the continuous control and regulation of home automation - a 'fully automatic branch'; Also, to improve the operating comfort for and to avoid operator errors by the employees in the market. A filter system with self-cleaning function reduces energy consumption and reduces service use.

A holistic analysis of the existing situation was at the beginning of the project. Given Germany's 200 dm stores were for example in terms of energy demand and consumption or CO2 examines emissions. The concept was developed on this basis.

In the project, dm, the GERTEC planning company, ID Ingenieurbüro worked as an advisory engineering office and a large group of exporting companies. A great deal of importance was attached to long-term cooperation with the same assembly and maintenance partners, a continuous training of the partners and manufacturers to the dm-Haustechnik concept as well as the assurance of quality by a working group of all project participants.

With the Commercial Cold the Race

Project: R134a / R744 Cascade for refrigerated and freezer rooms at Cytec Solvay in Östringen

For Cytec Solvay in Östringen, a new freezer store 'Freezer' was installed with cooling room 'Coolroom' in front of it. By means of two R134a / R744 (CO₂) cascades, which were installed on the roof of the building in two art containers, the Cool Room at + 4°C (R134a) and the freezer at -23°C (R744) is cooled. Each cascade operates as a stand-alone system, achieving a 100% redundancy. Despite higher investment costs, the decision was based on a system with natural refrigerant. The technical features include an elaborate oil management system, heating of the condensation water troughs and pipelines, a gas warning system in the technical containers, container cooling with inverter split devices, integration of the cascades into a process control system with trend recordings of the measurement data, archiving of fault messages and visualisation of the fault messages Cascades over touch panel. In addition to the use of SPS, the systems have also been equipped with a monitoring system, which ensures even higher system availability, efficient operation and optimized maintenance. The structural conditions permitted only a gradual cooling of the rooms by 3 K per day (14 days until the freezer reached the setpoint). This was controlled by the Rütgers monitoring system.

The technical requirements were elaborated by the planners (Rütgers) in detail and made available to all project participants. This included a detailed schedule for assembly and commissioning, site planning of the containers and condensers, a meticulous calculation of the long piping routes, which should be as hidden as possible, but still accessible, the planning of the electrical installation and the material deliveries as well as the safety management on the construction site (High safety regulations on site). Commissioning was carried out jointly by technicians from Rütgers and Christof Fischer. After the planning by Rütgers, Fischer designed the composite cold packs. In agreement with Rütgers and Fischer, the cascades were installed directly into the containers delivered to Fischer.

The Special Prize of the Jury Wins

Project: Construction of TWK - Test- und Weiterbildungszentrum Wärmepumpen and Kältetechnik GmbH in Stutensee near Karlsruhe

The new building of TWK GmbH received a special prize from the jury. Interestingly, this facility is a special place for a test and training center, with which it is difficult to compare projects from the free economy.

Within the framework of the TWK new building an innovative energy concept was implemented to enable an energy-efficient and greenhouse gas-saving supply of the building (heating and cooling) on the basis of the waste heat of test stand heat. The innovation of the heating and cooling system is the combination of thermo-active component systems (TABS) for building heating with a 93 m³ water-based Latent Heat Storage unit (LWS), which is coupled to a heat pump system. The system is to be used as a laboratory facility within the scope of the TWK training programme.



The special prize of the jury wins; Project: Construction of the TWK - Test- and...

A significant part of the waste heat generated during the cooling period (summer) from the test rigs in the test facility, as well as the cooling load in the building, are fed to the LWS, and heat pumps are used to heat the building during the heating season (winter). The energy transfer system for building heating and cooling is designed with the TABS at low temperature in order to enable the most economical operation of the heat pumps. The planning of this innovative energy concept was developed by Dipl.-Ing. Fritz Nüßle and implemented Haustechnik with the help of the companies Uponor, Speeter and Herrmann.

One of the challenges faced by the client was to realize individual wishes for the use of buildings and energy efficiency with the requirements of profitability within the given financing framework. It has been shown that industrial construction with prefabricated components involves certain limitations in the design of the architecture, but on the other hand it leads to considerable savings in the investment. However, there are also limits here, especially if the client is striving for a heat-cooling composite installation that has hitherto been unusual in commercial buildings. After weighing all the advantages and disadvantages, the client decided to separate TGA trades separately from local planning and specialist companies.

In close cooperation with all the companies involved in the project, the concept was gradually developed in many meetings and completed within a short construction period. The expert planner Fritz Nüßle, the employees of the firm Herrmann during the implementation planning and assembly as well as Yannik Fries from the Hochschule Karlsruhe, who wrote his master thesis about the system, were involved in the realization of the TGA concept. By donating many companies (such as heat pumps and refrigeration machines as well as state subsidies), this innovative energy concept was made possible.

The new development project of the TWK GmbH was promoted by the State Environment Ministry of Baden-Württemberg as a lighthouse project for energy efficiency and innovative energy concepts.

Chillventa Award 2016: The jury

- Christoph Brauneis, Chief Editor, KKA and tab
- Prof. Dr.-Ing. Michael Deichsel, Nuremberg University of Technology Georg Simon Ohm
- Rolf Harig, Harig GmbH
- Dr. Rainer Jakobs, Information Center Heat Pumps and Cooling Technology IZW
- Prof. Dr.-Ing. Ulrich Pfeiffenberger, Gießen-Friedberg University of Applied Sciences, Fachverband Gebäude-Klima
- Bertold Brackemeier, Manager Public Relations, NürnbergMesse. ■

3M introduces Filtrete Whole House Air Fresheners

Filtrete Brand from 3M comes up with a new way to create fresher-smelling air throughout the home with new Filtrete Whole House Air Fresheners. Unlike candles and plug-in air fresheners that add fragrance to air in a particular room, Filtrete Whole House Air Fresheners release scented air to multiple rooms using the home's forced-air heating and cooling system vents.

Air passing through the filter is slowly and consistently scented for up to 30 days. The product is easy to apply – simply use the adhesive strip provided to stick the insert onto the frame of any 1-inch to 5-inch air filter.

The fresheners are available in five scents – vanilla, floral, linen, cinnamon and berry – and can be replaced during a monthly check of a home's air filter. It is recommended that air filters be changed at least every three months. ■

Website: <http://investors.3m.com>



Angelo presents Solar Refrigeration Panels to Maltese islands

Angelo Aquilina Refrigeration is the sole distributor and installer of Solar Refrigeration Panels in the Maltese islands. Malta benefits from at least 3,000 hours of unbroken sunshine every year. The potential of energy reduction makes the product more attractive as these results in substantial savings of 40 to 70% reduction in electricity consumption during sunshine hours, thus producing more UV and more electricity consumption savings, together with:

- Reduced electricity overhead;
- Reduced ongoing equipment maintenance costs;
- Extended lifespan of equipment;
- Reduced CO₂ emissions. ■

Email: info@angeloaquilina.com



Broan-NuTone ULTRA Green series gets awarded

Continuing in the tradition of best-in-class ventilation products, 36 models in the Broan-NuTone ULTRA Green series were recently awarded the ENERGY STAR Most Efficient 2016 designation. The products recognised in each category are those that deliver cutting-edge energy efficiency along with the latest in technological innovation.

Broan-NuTone has stylish ventilation options to fit any situation, from a retrofit to new construction, and leads the industry with the widest variety of ventilation products available. The ULTRA Green ventilation fans are almost 10 times more efficient than the basic ENERGY STAR standard requirement.

The ULTRA Green ventilation fan series is available in both single speed and multispeed versions. Multispeed models are ideal for meeting whole-house mechanical ventilation requirements in green building programs such as LEED, ENERGY STAR or building codes such as California Title 24. Since whole-house fans may run all the time, choosing an efficient ENERGY STAR-qualified fan is especially important. For even greater ease of use, models with ULTRA Sense Humidity or Motion Sensing Technology will automatically adjust to maximum CFM levels when the need is detected. ■

Website: www.broan-nutone.com



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Date: 5th to 9th February, 2017

Website: www.cti.org

Campus Energy 2017

Venue: The Hyatt Regency Miami, Miami Florida

Date: 20th to 24th February, 2017

Website: www.cvent.com

Climatización Y Refrigeración 2017

Venue: Feria de Madrid, Madrid, Spain

Date: 28th February to 3rd March, 2017

Website: www.ifema.es/climatizacion_06/

Aqua-Therm

Venue: IEC Crocus Expo Centre, Moscow

Date: 7th to 10th February, 2017

Website: www.aquatherm-moscow.it

Acrex India

Venue: India Expo Centre (IEML), Greater Noida, Delhi

Date: 23rd to 25th February, 2017

Website: www.acrex.org.in

HVACR Vietnam

Venue: Saigon Exhibition and Convention Centre (SECC), Vietnam

Date: 29th to 31st, March 2017

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Shopping Centre In Danzig Runs On Climaveneta Units



Metropolia Gallery in Danzig...

Light and water are the main decorative elements of the Metropolia Gallery in Danzig, which is connected by several bridges to the adjacent train station. The building is fully illuminated by LED lights, and a large fountain welcomes clients in front of the main entrance. Another large wall-fountain inside flows throughout the whole building.

The interior design is based on the colour white, alternating large coloured lamps and colourful shop windows, running through the centre. In addition to the shops and the restaurants, the gallery also offers a modern multiscreen cinema, a fitness centre, a dance school and a children's play area of 1,000 square meters, one of a kind.

To keep an ideal temperature in this modern building, the HVAC designer has selected 6 high efficiency Climaveneta units: 2 FOCS2/K, 1 NX/K 0252P all in key efficiency, compact version, 2 NECS chillers with hermetic rotary Scroll compressors and 1 BRAT2 0041M air source chiller for a total cooling capacity of 4,183 kW. ■

Henning Larsen Architect Designs Frankfurt School

Frankfurt School of Finance & Management situated in one of Europe's leading financial capitals selected Henning Larsen Architects' design proposal for a new school located in the heart of Frankfurt. The 42,000 m² project is designed in collaboration with landscape architects ManMadeLand and engineering companies Innisus RR, Werner Sobek, Transsolar and BPK.

The building is made up of tall volumes creating an oblong, public zone in the centre that will become the central meeting place – and an open and inviting study environment. The visual link between the new school and Frankfurt's central business district will strengthen the connection between the academic and commercial environments.

The international competition for Frankfurt School of Finance & Management's new building was arranged in collaboration between the School and the City of Frankfurt. Henning Larsen Architects competed against four invited teams, including world-renowned architects Zaha Hadid, OMA and Dominique Perrault. ■



The building is made up of tall volumes...

Siemens technology controls "Office of the Future"



The world's first office building produced by a 3D printer...

The world's first office building produced by a 3D printer has been opened in Dubai. The 250-square-metre 'Office of the Future' was built using a 3D printer measuring 20 feet high, 120 feet long and 40 feet wide, and erected near the Emirates Towers in Dubai. The building technology with access control and surveillance systems was provided by Siemens. Those are integrated into a central building management platform. The technology ensures low operating costs and reduced energy consumption.

The key components of the 'Office of the Future' are integrated with the help of Siemens' Desigo CC building management platform. The platform enables the control and optimisation of the building's technical infrastructure, surveillance, air conditioning and access control systems from a central location. A customised platform displays the status of the various systems in real time, enabling operators to accurately monitor and control the building's performance.

The Desigo CC building management platform is also able to accommodate a wider range of building systems including heating, ventilation and air conditioning, power, lighting and shading, and more components can be added when requirements change. Worldwide installations of Desigo CC have led to reductions in building operating costs of up to 20%. ■

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