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February 2016

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A S Controls Pvt Ltd

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Model Pysclone – Telaire Thermo-Hygrometer Measure 18 units / Parameter



Series SBLT – Dwyer Submersible level Transmitter



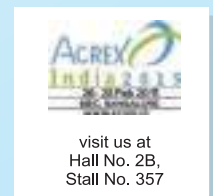
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Publisher's Letter



Publisher's Letter

Strong movement to switch over to CO₂ as refrigerant is on the spree

India is the largest producer of fruits and second largest producer of vegetables in the world. In spite of being on the top, per capita availability of fruits and vegetables is quite low because of post-harvest losses which account for about 25% to 30% of production. This requires building cold chain and enhancing cold storages capacity.

HVAC systems have become one of the core building blocks for modern infrastructure, encompassing various sectors. All these factors are expected to spur the market for HVAC systems in India. The write-up 'Growth of HVAC Industry in India' highlights with anticipated growth in FDI, several international players are expected to start operations in Indian retail market which is projected to reach US\$726.62 billion by 2019, which is expected to further fuel the country's HVAC market.

A strong movement to switch over to CO₂ as refrigerant is on the spree. In their continuous pursuit for environment friendly refrigerants and with the global mounting pressure, Container Refrigeration machinery manufacturers have come out with some innovative improvements. The article 'New Innovations in Container Refrigeration' discusses various new technologies for global transport temperature control.

India is blessed with solar energy, for 200-250 days per year. Sardar Patel Renewable Energy Research Institute has developed a solar-biogas hybrid transient storage system funded by National Agricultural Science Fund (ICAR). The article 'Solar Refrigeration Technology for On-farm Transient Storage' reveals about operation of such systems.

Do visit us at **Hall No. 2B, Stall No. 333-A**, during **ACREX 2015, Feb 26-28** in Bangalore.

Please send your comments at pravita@charypublications.in

Pravita Iyer
Publisher & Director





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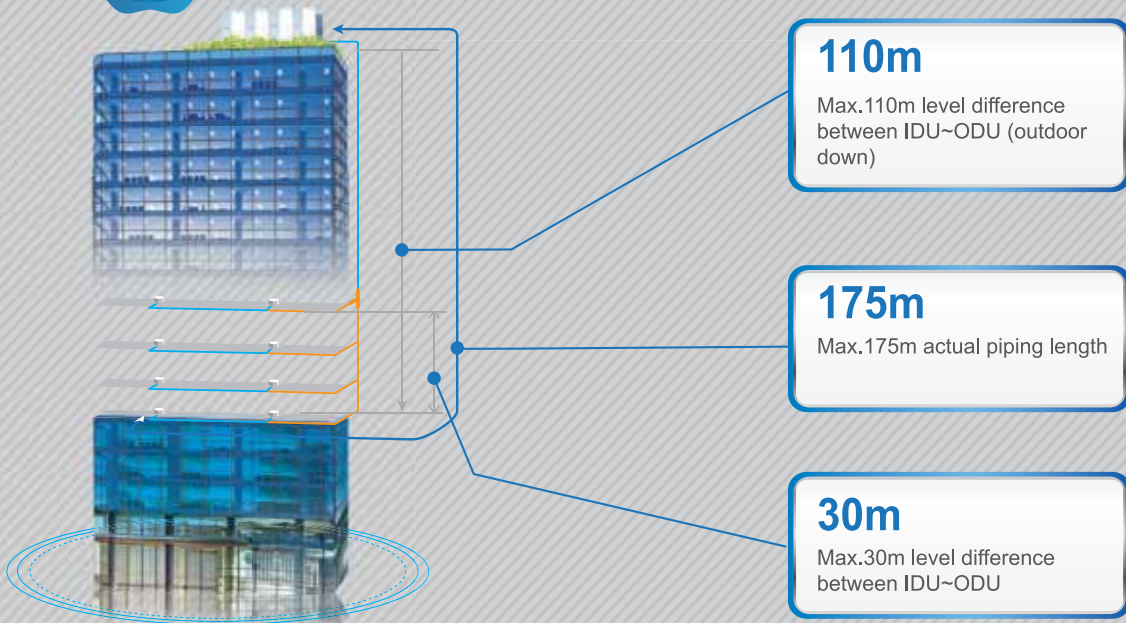
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Diamond Shaped Design

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The solution offers a piping length of 1,000m and level difference of 110m, making it perfect for large projects.



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*Durability Comparison in Refrigeration Racks
Carlyle Compressor, Stone Mountain, Georgia, USA, viewed 3 February 2015
http://www.carlylecompressor.com/corp/details/0,2938,CLI1_DIV24_ETI11584,00.html

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Editorial

Using Natural Refrigerants for Sustainable Development



Refrigeration necessity for food industry requires controlled temperature maintenance for transportation and preservation of food, to avoid food waste. This underlines the role of refrigerants in cooling and freezing food. The reason for using ammonia, because of its zero ODP/ GWP makes refrigeration industry more environment friendly.

There are increasing concerns about global climate change. To reduce emissions of greenhouse gases and adherence to the standards and policies is the norm across Europe. R404A, blend of HFC refrigerant and R507, a non-ozone depleting HFC option are used as replacement for medium and low temperature refrigeration. HCFCs because of their high GWP are under threat in Europe, following adoption of F-Gas regulations.

International Association of Refrigerated Warehouses into existence since 125 years understood long-back, the increasing challenge of storing perishable food and complexity of operating temperature controlled storage facilities. In India, cold chain sector is driven by increasing demand for perishable products as well as a persistent need to reduce waste of agricultural and perishable products. According to IARW's 2014 Global Cold Storage Capacity Report, total capacity of refrigerated warehouses was estimated at 552 million cubic meters worldwide in 2014, with cold storage capacity of US at 115 million cubic meters. India 131 million cubic meters, and China, the third largest with 76 million cubic meters of capacity. Cold storage capacity has shown a growth rate above 5% per year during a sustained period in 17 nations and the long-term growth rates are the highest in India, China, and Turkey.

In fact, ammonia, found in nature, is essential to earth's nitrogen cycle and its release in the atmosphere is immediately recycled, not contributing to the greenhouse effect protecting atmospheric zone. Ammonia refrigeration is perceptible as a strong system refrigerant for freezing and storage of both frozen and unfrozen foods. There needs to be concerted effort about reducing leak related emissions and maximizing energy efficiency. Global cooperation in organizing trainings for engineers, plant managers and end users is needed, to implement cost effective strategy to use natural refrigerants like NH₃, CO₂ or Hydrocarbon into new systems, proactively.

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Gopal Krishna Anand



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Smartcool Australia PTY merges with AERIS Environmental Limited

SMARTCOOL Smartcool Systems Inc. Ted Konyi, Chairman and CEO of Smartcool, reports that AERIS Environmental Limited has merged Smartcool Australia PTY., into its group of companies. Smartcool Australia Pty., an independent Smartcool distributor with some exclusive distribution rights in Australia, has distributed and installed Smartcool products over the past 10 years. Some of their Smartcool successes include providing Smartcool's energy efficiency solutions to large national and multi-national corporations. Chris Rogerson, President of Smartcool Australia, commented, "integrating Smartcool Australia into AERIS represents a significant opportunity to grow the installed base of Smartcool users. AERIS are extremely well connected in the medical, dental and property management markets. We are already seeing the benefits of our association with the recent installation in the first location of a large multinational retail chain." In having recently visited with the AERIS Group in Sydney, Ted Konyi stated "Peter Bush, CEO of AERIS, has a mandate to grow sales of Smartcool technology. AERIS has rebranded Smartcool as SmartEnergy and will be leveraging the strong business contacts of the principal shareholders of AERIS. Early indications suggest a large pipeline of multi unit installations that have already commenced installations and will build over the balance of the year. ■

ZIEHL-ABEGG India's plant at Chakan, Pune is now ISO 9001:2008 certified

ZIEHL-ABEGG Ziehl-Abegg India Private Limited- 100% Subsidiary of ZIEHL-ABEGG SE, Germany started its production facility in Chakan, Pune in 2013. This facility at Chakan, Pune has acquired ISO 9001:2008 Certificate issued by TuV Rheinland in Nov 2014. From the start of its operations in India, ZIEHL-ABEGG's aim and focus has been to provide German quality products from the Indian Factory. The products that are manufactured in this facility include Plug Fans for Air Handling units, ECblue fans for Air Handling units and other applications, Axial fans for condenser, chillers, Ventilation and other applications. Going forward more product categories shall be added, with an objective to cater to a wider band of application and helping our customers utilize the highly energy efficient and reliable fans. ■

Mitsubishi Electric India inaugurates MEQ Hiroba in Chennai

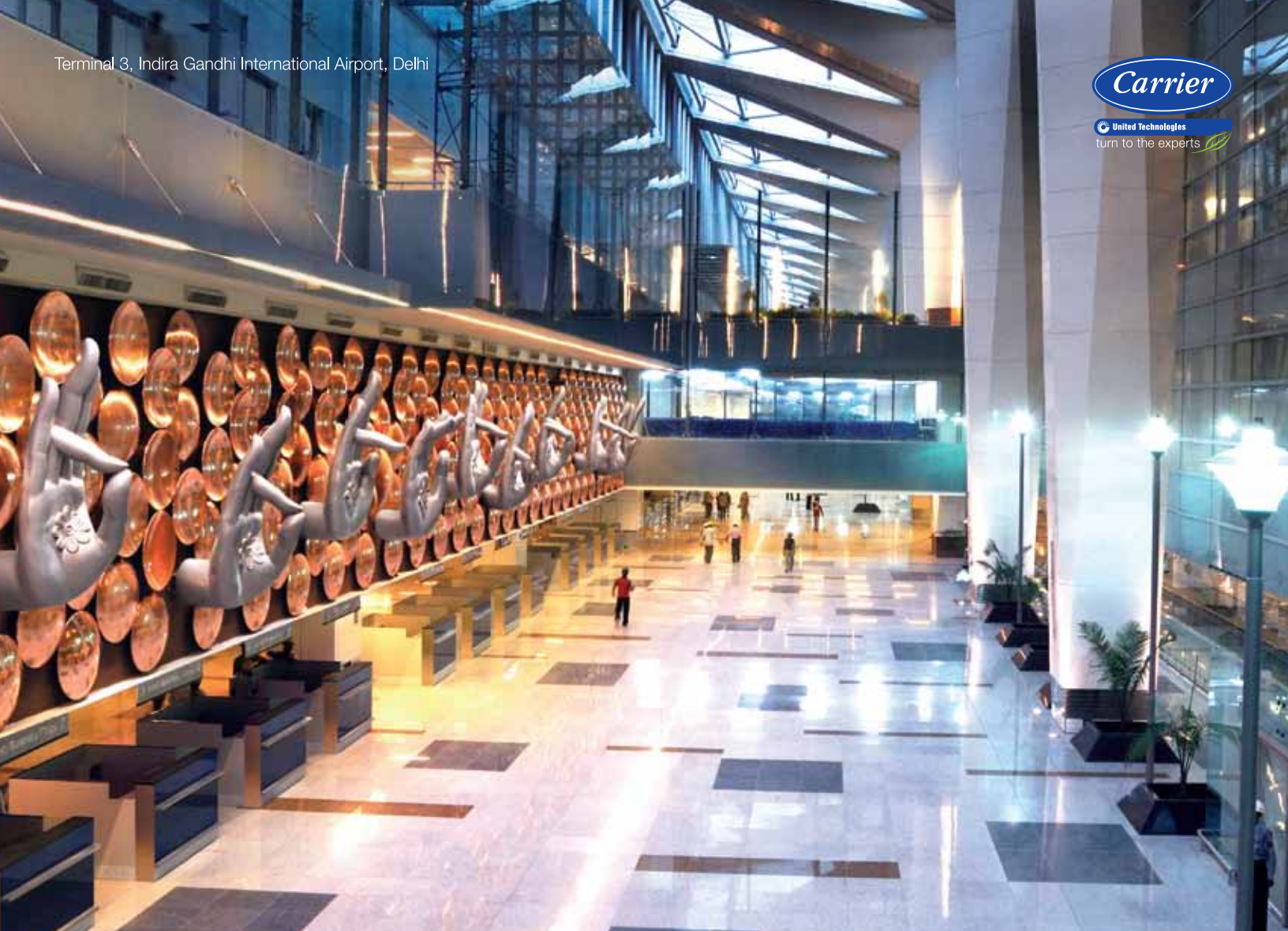
Mitsubishi Electric India (MEI), the global leader in the premium Air conditioning market today inaugurated its exclusive showroom for Air conditioners – "MEQ Hiroba" in Chennai amidst major fanfare & excitement. Showroom is located in Choolaimedu, Chennai. It is one of the many Hiroba(s) that Mitsubishi Electric intends to launch during this financial year aimed for nationwide brand awareness. Mitsubishi Electric products with highly advanced technology from Japan offers lower cost of ownership that will be topped with unmatched quality and durability. On the occasion of inauguration, Director & Business Unit Head of Air conditioners, Takashi Nishikuma said, "We have plans to become aggressive in our approach in the Indian market and the inauguration of these MEQ Hiroba(s) is a key step towards strengthening MEI's endeavour to establish itself as a major player in the consumer Air conditioner segment." General Manager-Sales & Marketing of Air conditioners, ■



Ingersoll Rand to acquire Frigoblock

Ingersoll-Rand plc, a world leader in creating comfortable, sustainable and efficient environments, announced it has entered into an agreement to acquire FRIGOBLOCK for €100 million. The acquisition is expected to close in the first half of 2015, subject to regulatory approval. Frigoblock manufactures and designs transport refrigeration units for trucks and trailers in Europe, primarily sold in Northern Europe. Frigoblock operates in Essen, Germany and is home to about 150 employees. The company's annual revenue is approximately €41 million. We expect the business to be accretive to EPS, EBITDA margins and ROIC in its first full year of operation. Upon closing of the transaction, Ingersoll Rand will welcome the Frigoblock brand into the Ingersoll Rand family of brands and will become part of the Transport Solutions business, which goes to market as Thermo King and is consolidated within the company's Climate Segment. The Frigoblock facility will become a global competence center for electrical and environmentally sustainable systems for transport refrigeration at Ingersoll Rand. The acquisition will add to Thermo King's strength in delivering safe, reliable and efficient transport temperature control systems for a variety of mobile applications. "Frigoblock utilizes innovative technology to deliver products with low fuel consumption and reduced noise which decreases environmental impact and creates differentiation in the market. Frigoblock products are known for reliability and built with high quality," said Ray Pittard, president, Transport Solutions, Ingersoll Rand. "This opportunity will allow us to offer customers in Europe and globally through our strong channels Frigoblock hybrid and non-diesel technologies." "We are proud that Frigoblock will soon become a member of the Ingersoll Rand family of brands," said Peter Großkopf, founder and owner of Frigoblock. "We believe Frigoblock will be joining a company that shares our values, such as innovation, integrity and customer focus. As part of Ingersoll Rand, Frigoblock will be able to have a greater impact on the industry and add even more value to our customers." ■





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Goodman establishes new base in Texas, United States



Aiming for medium- to long-term business expansion in the HVAC market of North America, Daikin Industries, Ltd. is establishing a new base in the suburbs of Houston through its subsidiary Goodman (Goodman Global Group, Inc., Headquarters: Houston, Texas, United States). The new base is being established to integrate the four factories that Goodman currently operates in the United States and the logistics base. Moreover, the new base will consolidate marketing and customer support activities to provide even greater operational efficiencies within the company. Construction of the new base will begin soon with base operations scheduled to start in the middle of 2016. Since the Goodman acquisition in 2012, Daikin has increased business in the North America region by utilizing the strengths of both companies. However, greater production capacity has become essential for achieving further growth. Together with enhancing Goodman production facilities, the new base will showcase Daikin's state-of-the-art production technology that is expanding to every region of the world and aim for significant gains in productivity to achieve nonstop creation of cost competitive products. Other expected benefits include optimal logistics efficiency through the melding of production and logistics in the integration of the logistics base with the four factories dispersed within the United States; inventory reduction through the sharing of components; and significant shortening of lead-time through improved efficiency in the delivery of finished products. In response to the tightening of energy regulations in the North American HVAC market, demand is rising for high efficiency in residential-use unitary air conditioning equipment, and greater sales of premium zone products are expected. Although sales first began at Goodman last year for residential-use products incorporating high-efficiency inverter technology, Goodman plans to also aggressively launch similar products for this fiscal year. Even in North America where conventional ducted products have remained mainstream, the ductless market is rapidly growing at an annual pace of more than 20%, and ductless products, such as the VRV air conditioning systems in which Daikin excels and residential-use split type air conditioners, are beginning to receive high acclaim for their overwhelming energy efficiency and comfort. ■

Johnson Controls and Hitachi agree to form global HVAC joint venture

Johnson Controls, Hitachi, Ltd and Hitachi Appliances, Inc. entered into a definitive agreement for their global joint venture while at the World Economic Forum in Davos. The new Johnson Controls-Hitachi joint venture will allow both companies to deliver the most diverse technology portfolio in the heating, ventilation, AC and refrigeration industry. Through the agreement, Johnson Controls will obtain a 60% ownership stake in Hitachi Appliances' more than ¥300 billion sales (approximately \$2.6 billion) global air conditioning business, excluding sales and service operations in Japan. The Johnson Controls-Hitachi joint venture will bring customers a full range of air conditioning products, including world-class variable refrigerant flow (VRF) technology, leading-edge inverter technology based room air conditioners and absorption chillers – on top of existing Johnson Controls products that meet global customer demands. The transaction is expected to close later this year, subject to regulatory approvals. ■



Victaulic brings new technology and benefits of BIM to ACREX

Victaulic, the world leader in mechanical pipe joining technology, will display a range of products that deliver innovative advantages, including faster installation and improved integration with initiatives such as Building Information Modeling (BIM) systems, at this year's ACREX India in Bangalore. BIM systems offer considerable benefits for engineers, consultants and contractors installing pipe, and Victaulic has taken extensive steps to allow users to effectively integrate its products. On an individual project level, the company's experts now work with designers to help them understand how products can be best used and routed in specific software. "Victaulic delivers a service from the pre-planning and design stages of a project to the operation and maintenance of installed building services", says Pankaj Soni, Victaulic Country Manager India. "Just as CAD and prefabrication revolutionised design and construction, so BIM is set to become standard practice and add to the efficient whole-life management of building projects." As well as a global network of experts in its Construction Piping Services (CPS) department, Victaulic has a team of specialists in Mumbai who handle project design, technical and financial analysis, 3D modeling, installation plans and project management. Recent product innovations from Victaulic on show at ACREX includes an extension to the company's popular QuickVic Style 107N line of Installation-Ready rigid couplings. With installation up to ten times faster than conventional pipe joining methods, the company's innovative pipe joining solutions were recently employed in the Cisco Global Development Center in Bengaluru in its HVAC and Fire Protection systems. "Victaulic offers complete solutions that appeal to a wide range of markets," adds Soni. "BIM systems offer considerable benefits when installing pipe, and Victaulic has taken extensive steps to allow users to effectively integrate its products." ■





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Shakti Pumps signs MoU with RBL Bank for funding Solar Pumpsets

Shakti Pumps (I) Ltd, leading manufacturer of 100% stainless steel pumpsets & solar pumps in India signed a Memorandum of Understanding (MoU) with RBL Bank (also known as Ratnakar Bank) to provide loans to its customers for buying Solar Pumpsets and host of products across the bank's network. The company has signed a preferred financier agreement with RBL Bank, under which Shakti Pumps customers, primarily the farmers will be able to secure credit for a range of products. The focus will be on funding the purchase of solar pumpsets but farmers will also be able to secure finance for buying PVC pipes and drip irrigation products. ■



Green Building Initiative recognizes ASHRAE for their four Green Globes Achievement



Jerri Yudelson, Green Building Initiatives president, presented rating system

certificate to ASHRAE President Tom Phoenix during ASHRAE's 2015 Winter Conference held in Chicago, Illinois. Green Building Initiative, a nonprofit organization committed to accelerating the adoption of sustainable building practices and providers of the Green Globes® rating system, congratulates ASHRAE on achieving the highest rating, of four Green Globes, on their international headquarters. "ASHRAE represents the 'gold standard' for building energy efficiency standards. We're pleased that ASHRAE now stands at the pinnacle of achievement for green building, with the award of four Green Globes for its Atlanta headquarters building from the Green Building Initiative. Through a months-long process, GBI's Green Globes Assessor worked with ASHRAE staff to document the building's sustainable management practices. Only 3% of projects assessed by GBI achieve four Globes certification, so this recognition is a rare honor and a tribute to ASHRAE's enlightened building operations," said Yudelson. ■

New Fire Ready Kitchen Hood available from Greenheck

Greenheck's new Fire Ready Hood, Model GRRS, functions as a standard ventilation range hood with the added capacity to suppress stove-top fires, addressing the challenge of protecting residential-style appliances used in commercial settings.



Designed for use over a standard 30 or 36-inch residential range, Fire Ready Hood incorporates a UL300A Listed self-contained, commercial-style automatic fire suppression system. The hood's exhaust fan can be either manually operated with the face-mounted dial or automatically operated based on the hood temperature that is monitored by an onboard controller. If the hood temperature is elevated beyond normal operation, the controller will disable the appliance via the factory-supplied appliance disconnect. An audible alarm and dry contact will be engaged to alert occupants and building alarms of elevated temperatures. If temperatures continue to rise beyond the rating of the system's fusible link, Amerex 660 agent will be released through four nozzles directed at the appliance and one nozzle into the exhaust duct. The Fire Ready Hood is ideal for applications where residential-style appliances are used. ■

Cool-Therm rolls-out cloud-based remote monitoring and diagnosis for Turbomiser chillers

Cool-Therm Ltd, a pioneer in the development of the ultra-efficient Turbomiser chiller, is now able to monitor and diagnose chiller performance via the Cloud and GSM, with major potential benefits for engineers and end users. Turbomiser chillers are now equipped with



specialist communications hardware and software, enabling them to remotely transmit and receive data. The system can connect to a local cellular GSM network, or be accessed via Ethernet. Connection requires the end user's permission, but once authorisation is given enables engineers to monitor plant performance remotely, and diagnose potential problems prior to – or overcoming the need for - a site visit. Alex Strong, Cool-Therm's technical director, says, "There are obvious benefits in terms of time saving and reducing carbon emissions by cutting vehicle miles. It enables engineers to remotely check on alarms and make permitted adjustments to operating parameters without attending site. It also allows us to brief the customer on chiller problems without incurring an engineer site visit charge. Importantly, the system is completely secure and can only be activated and accessed with the explicit authorisation of the equipment owner." Engineers can connect to the chiller via Ethernet, and Turbomisers are equipped with a data SIM which can connect with the GSM network. While in GSM mode, data is not streamed constantly, but channels are opened if an exceptional event occurs, such as an alarm/fault or parameter change, and the data is automatically transmitted. Such exceptional events are recorded on a Cloud-based archive on the manufacturer's web portal, which in turn is able to email plant supervisors and end users with notifications. Although the system is managed through Geoclima's Web Portal, Cool-Therm has its own dedicated software enabling direct connection with its chillers. ■

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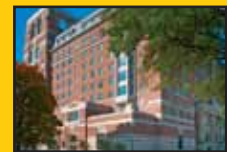
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Moduleair Advanced Air cooled Condenser selected for Red Leaf Shale Oil Extraction Plant



A Module Air Cooled Condenser (ACC) developed and manufactured by SPX Cooling Technologies, Inc.

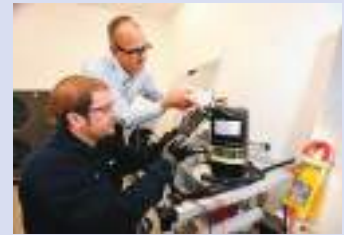
will provide process cooling of exhaust steam as part of the power generation operation at the Red Leaf Resources, Inc. (Red Leaf) shale oil extraction process plant in Seep Ridge, Utah. Natural gas produced at the site will power two boilers serving a 7 MW steam turbine generator. The ModuleAir ACC will condense exhaust steam from the steam turbine and return condensate to the boilers through the use of dry cooling, thus eliminating water usage from the cooling process. The plant is expected to be operational in late 2015. The innovative modular design of the ModuleAir ACC provides factory-assembled structural components, duct and heat exchanger bundles to shorten construction duration and reduce construction costs. Advantages of its advanced condenser design include improved performance during low ambient conditions and enhanced annual average power plant output. The lower height and smaller footprint of the ModuleAir ACC also reduce visual impact at the site. Major benefits provided by the ModuleAir ACC include long term mechanical and thermal integrity, excellent corrosion and freeze resistance, low fan power consumption, reliable operation and low maintenance, elimination of water usage and flexibility in power plant site selection. The Red Leaf Seep Ridge plant will utilize the EcoShale® In-Capsule® Process developed and patented by Red Leaf, South Jordan, Utah. The process involves heating mined shale in a closed surface impoundment or capsule to produce high quality feedstock. The production of high hydrogen content natural (produced) gas is a by-product of the extraction process. The utilization of this produced gas for power generation represents captured value that would otherwise be lost potential in the shale-oil extraction process. The project requirements include the use of this produced gas for power generation. Environmental benefits of the EcoShale process include limited water consumption, integrated reclamation, low emissions and protection of groundwater. ■

Haier Group achieves Three Decades of customer inspired Innovation globally

Haier, one of the largest Home Appliances & Consumer electronics brand globally and world's no.1 brand in refrigeration appliances completed its 30 years of successful journey in 2014. Haier's 30th anniversary is the perfect opportunity to reflect on the unique success story behind a brand that has shaken up the global household electrical market. In the year 1984, Haier group commenced its journey by taking a bold step of acquiring a Qingdao-based refrigerator factory with its 600 workers. Shortly, Haier realised that the quality in the product is missing and to emphasise the importance the company needed to place on quality. Reminiscing this incident, Zhang Ruimin, CEO of Haier Group said, "There is no A, B, C, or D quality; there is only acceptable and unacceptable. A focus on quality standards has not wavered in the 30 last years and this legacy will be further strengthened in years to come." The Haier Group today, employs 70,000 people and has considerable presence in more than 100 countries worldwide. The group boasts of five research and design centres, including that in Nuremburg in Germany & Compo Doro in Italy. ■

Airedale extends training programme for 2015

Leading British manufacturer of precision air conditioning, IT cooling systems, chillers and air handling units, Airedale International, has extended its training programme for 2015. With more than 100 days of tuition available at its Leeds (UK) training school, the cooling specialist offers a wide range of theoretical and practical courses for newcomers to the industry as well as those with experience. Airedale's courses range from refrigeration and air conditioning basics to installation, commissioning, maintenance and design principles. A CITB Construction Skills approved centre, the cooling systems expert also offers industry recognised training in F-Gas J11, Essential Electrics and JO4 & JO5 Pipework & Brazing. New for 2015 Airedale has also added one-day refresher sessions in F-Gas J11 and Essential Electrics to allow certifications to be kept up-to-date in line with legal requirements. For larger groups, Airedale will work with clients to design tailored sessions covering topics such as psychrometrics, component identification and uses, sound & sound measurement, airflow in ducted systems and controls. The British manufacturer, first established in 1974, has also now extended its training programme to clients, contractors, engineers and business partners throughout the Middle East. The portfolio combines Airedale's more traditional courses in ACR and data centre technologies with elements from its portfolio of CIBSE accredited continuing professional development (CPD) sessions which have been well received within the UK since introduced early in 2014. CPD subjects available cover energy optimisation strategies including free-cooling technology and aisle containment, in addition to energy efficiency measurements and how they are considered as part of system design, low global warming potential (GWP) refrigerants and other topics. To support the theoretical classroom sessions, delegates are provided with opportunities to develop their practical skills using the dedicated air conditioning and electrical training rigs and brazing assemblies. ■



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Typical case study data of a 1200 TR Chiller

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



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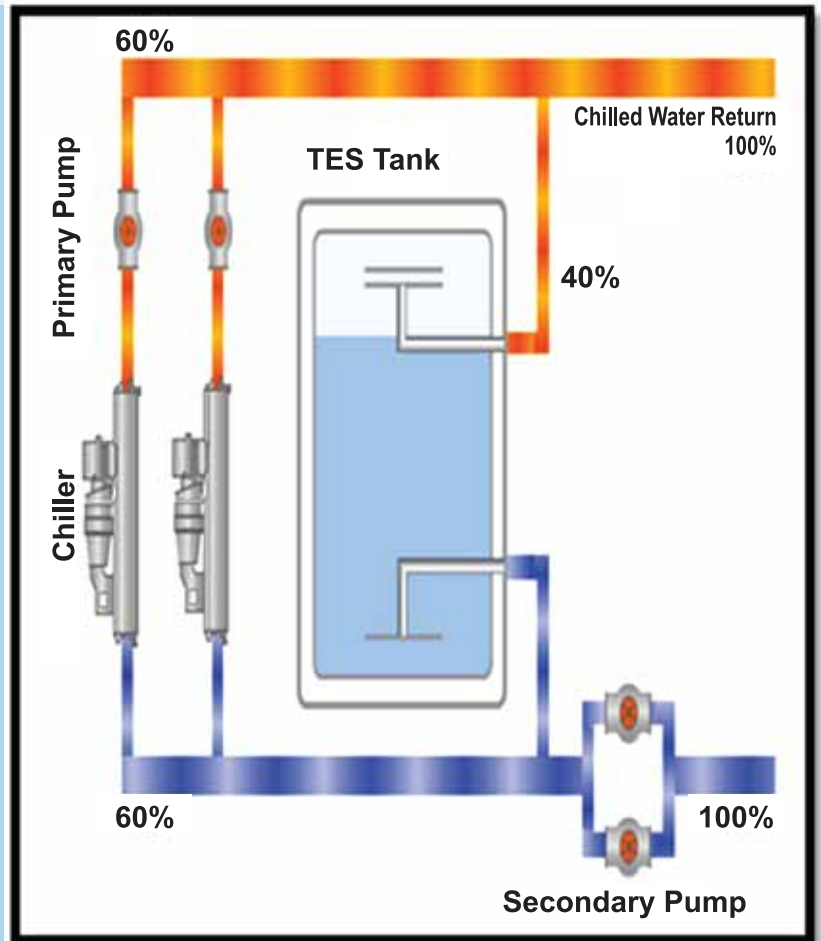
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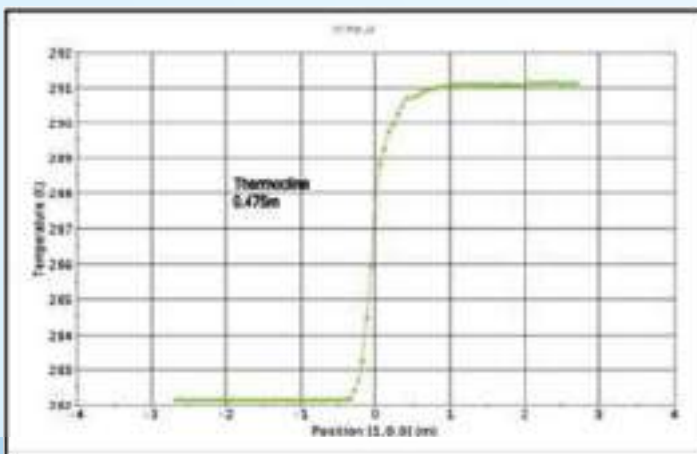
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- ❖ Environmentally friendly system free from brine.
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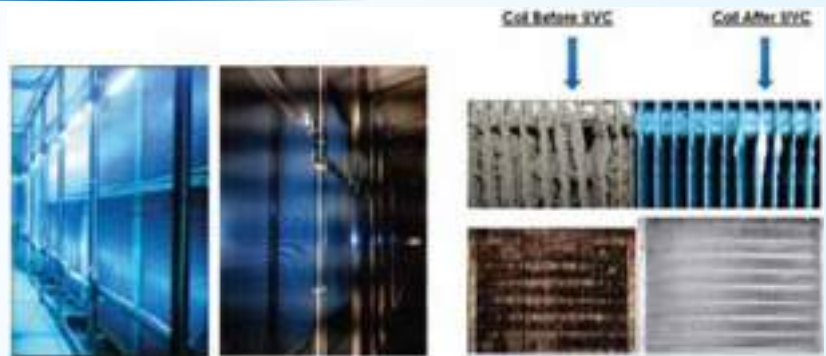
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Call for submissions for the Natural Refrigeration Award 2015

eurammøn For the sixth time now, eurammøn is calling on young scientists to enter their final theses or dissertations on research in the field of natural refrigerants for the Natural Refrigeration Award 2015. The prize which is awarded every two years is endowed with €5,000 and will be presented this year by eurammøn together with the Zhongyuan University of Technology, China, and the South African trade journal The Cold Link. Interested candidates can submit their applications by March 27, 2015. "The Natural Refrigeration Award aims to underline the significance of natural refrigerants and make young scientists more aware of just how important they are", explains Monika Witt, eurammøn chairwoman. "Newly developed systems that are environmentally friendly with energy-efficient operation based on natural refrigerants offer great potential for the future. With this Award, we intend to promote research activity in this field and drive innovation actively into the future", says Witt. The Award addresses students, graduates and doctoral students at universities, colleges and similar educational institutions whose dissertations have been officially accepted as part of their bachelor's, master's or doctoral degrees. The dissertation must look at the use of natural refrigerants in refrigeration technology, including for example ammonia, carbon dioxide, hydrocarbons or water, and it must have been assessed in the period between July 2013 and March 2015. The submission must consist of an English abstract, the completed application form and the dissertation. A jury of international experts and representatives from science, business and the media will assess the submissions and select the top three places. ■

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Alfa Laval India expands 'Two ways to market' Distribution Business

In line with the Company's Equipment Division's two ways to market strategy and aim towards Double Distribution growth, Alfa Laval India organised its third annual Distributor's Meet on 29th January 2015 in Pune. With the event theme of Indian national bird Peacock spreading its tail feather symbolising "Explore the Potential. Spread." the company drove the message of exploring the potential of distribution growth and spreading the reach (to customers) on the India market. Ms. Susanne Pahlen Aklundh, Head & Executive Vice President EQD, Alfa Laval shared the outcome of the Equipment Distributions two way to market strategy so far and the focus for the time ahead for the Global Distribution Strategy while Mr. Lars Dithmer, MD Alfa Laval India talked about the potential India offers for growth of distribution business. Kumud Jhamb, VP & Head EQD, India presented the vital 3 priority areas for realising growth ambitions in 2015. ■



CES Group and Eaton-Williams next-generation high density Cooling System

ServerCool system represents the latest technology for high density cooling. Crowd at SC14 conference saw next generation of high density cooling solutions from CES Group and its affiliate Eaton-Williams, which are suited to high performance computing. Supercomputing 2014 marked 26th anniversary conference of high performance computing, networking, storage and analysis and drew 10,198 registered attendees. A ServerCool® active rear door heat exchanger and cooling distribution unit from Eaton-Williams was displayed in the CES Group booth. Mark Luxford, ServerCool's General Manager at Eaton-Williams comments, "System offers both efficiency and reliability to help data center operators reduce power usage effectiveness (PUE) while delivering the precise temperature and humidification control required by high performance data centres." Eaton-Williams rear door heat exchangers (RDHx) provide 100% heat rejection at source and up to 65kW of cooling per rack. Available RDHx models include active, passive and microchannel doors. The Cooling Distribution Units (CDUs) deliver close controlled water cooling for up to 20 rear door heat exchangers. The CDU absorbs only 4kW of power and will deliver up to 305kW of cooling. In addition, the CDU has N+1 reliability built in and if two CDUs are used in tandem, can provide Tier 4 resilience. The ServerCool high density cooling system is just one of the full line of data centre solutions from CES Group, which has been providing cooling systems and applications expertise for mission critical facilities for more than 30 years. CES Group is the largest custom HVAC manufacturer in North America with 11 manufacturing facilities and 150 sales representative offices. CES Group provides critical infrastructure for the world's leading data centres through cooling solutions that meet the unique efficiency, redundancy and scalability requirements of data centers. The innovative technologies behind those solutions include patented Fanwall Technology®, free cooling units, air- and water-side economizers, advanced controls and data centre cooling optimization software in a DCIM platform. ■



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A Redefined Engineering Analysis of HVAC&R Industry



Since from the time of evolution of air conditioning system, there has been an inordinate advancement and development in technology till date.

There was a time when the scope and purpose of air conditioning system was limited up to cooling of an enclosed space. But with the fast movement in technology, the application of air conditioning system has captured a vast locale in almost all the industries. In the present scenario, the application of air conditioning system is no more limited up to cooling of space or lowering down the temperature for human comfort. With the continuous approaching demand in various industries like hospital sector, semiconductor industry, hotel segment etc. air conditioning field has grown-up into a gigantic structure and shaped itself in a new outstanding appearance, what is called HVAC&R industry.

The acronym for HVAC&R is Heating, Ventilation, Air Conditioning & Refrigeration and its scope of function covers the proper circulation of air, upholding of appropriate temperature

as desired (both cooling/heating), balancing of relative humidity levels, maintaining defined class of cleanliness and above all, controlling noise levels within the specified limits. While covering all these scopes, certain guidelines have to be followed simultaneously and certain protocols have to be followed concurrently for the establishment of a legitimate HVAC&R system. These guidelines and protocols must be adhered strictly confirming to certain standards initially from the design stage till the final commissioning stage of the project or job.

There is always an urge for the scheduled completion of project in the present fast moving trend prevailing in HVAC&R industry. This approach is not only limited up to HVAC&R project management but it is also very common in HVAC&R facility management. Due to haste there always happens waste, either in terms of money, manpower,

Y S Rao, Mechanical Engineer and a Certified Energy Manager by Bureau of Energy Efficiency, has working experience of 16 years in HVAC&R industry in India & abroad (Bahrain).

Presently, working with one of the India's leading MEP contracting company. He is accredited with the Certificate of Completion for "Refrigerant Usage Certification Prep under EPA Section 608" and is also member of ISHRAE Nagpur Chapter.



machinery, time or materials. The loss of all these resources is due to unplanned work culture, inexperienced team members, unprofessional approach, unethical morale and above all due to unstructured management. All these symptoms are generally observed in untailed contracting companies. When such untailed contracting companies are awarded with a high value work orders for execution of esteemed projects, the end result will always be a muddle and the project itself turns up to be a never ending nightmare. It is also interesting to note that, in India such uncultured contracting companies are established in huge numbers. These contemptible contracting companies neither employ qualified professionals nor do they possess skilled manpower to execute and conclude a project in all respects.

Despite immense advancement in technology in the field of HVAC&R industry, India is still footing behind for executing HVAC&R services because of the following reasons:

- In India, so far no government authority is established to validate the HVAC&R system installation techniques & methodology applied.
- In India, there is no government

body or agency deployed to check the compliance of guidelines & protocols laid down by Bureau of Indian Standards for HVAC&R industry.

- In India, there is no regulatory government organization to lay down mandatory rules and to establish the eligibility criteria for the selection of a technician and to issue permit to a worker based on qualification/certification/license to work in the field of HVAC&R.
- In India till date, there is no legislative body/bureau to check the power consumption and the energy saving potential in any of the HVAC&R projects.

We, the people of India feel proud to be excellent enough in science & technology but always fail to maintain perfection when it comes to quality, stability, durability and purity of a mechanism. Indians are never been a part of continual improvement process especially in HVAC&R field. Undoubtedly HVAC&R industry has grown at a faster pace in India and has also captured an immense volume of business, but unfortunately couldn't improve in acquiring excellence, rightness, exactness and flawlessness. With the growth of business volume in Indian market, many petty contractors and entrepreneurs are going ahead to establish their set-ups in HVAC&R sector despite of their economic incapability and financial instability. The government of India has adapted a policy to encourage small scale industries and promote minor entrepreneurs. But the law of land doesn't enforce any control nor have a check on the eligibility of immature contractors and their staff. The depressing consequences of this haphazard act for promoting unqualified, untrained and unskilled workmen to establish their own set-up has exploited

the HVAC&R industry in totality. The present widespread condition in HVAC&R industry in India is that even an uneducated and untrained technician after attaining 2 to 3 years of experience turns to be contractor without any resources to sustain in the market. Such raw and petty contractors mess up the projects when the work-contracts are awarded to them. Furthermore it is also fascinating to know that, a few of the major contracting firms proclaim themselves to be the "leaders in Air conditioning" in Indian market and grab high value contracts. Such contracting firms usually deploy incompetent and uneducated staff collectively with untrained Engineers, uneducated Supervisors, inexperienced Designers and incompetent Managers who are hired at a very low pay and let them to work on prestigious projects. The final outcome of such an irrational and imprudent operation is project mess up accompanied with total wastage of time, loss of money, idling of manpower, and scraping of materials.

Disordered Installation vistas at a Renowned Hospital Project

This article covers few of the most common panoramas which were recorded at a renowned hospital project and alarms to wake up those Indians who are engaged as professionals in this field of HVAC&R. Every professional working in HVAC&R sector might have come across such episodes at certain point of time and might have eventually ignored or might have left uncared.

Observation 1: A disgusting scene mostly visible at the said project site was that the branch ducts and the main ducts were suspended by tying them with electrical wires/cables or ropes. Fig. 1 shows a depressing method applied for installation of ducts. The view

shown in Fig. 1 gives a feel about contractor's inability to arrange skilled manpower at site and the lacking capacity to make arrangement for required ancillary materials at site. The supports provided to the ducts may not be sturdy enough to withstand the weight of the sheet metal ducts and may likely to break off thereby causing accidents.



Fig. 1: Branch Ducts Dangled by Using Electrical Wires/Cables

As a standard practice, these sheet metal ducts should be rested on MS angel supports/GI slotted channel supports of recommended size and should be hanged by using threaded rods of specific size.

Observation 2: Maintaining uniformity in the level of BOD (i.e. bottom of ducts) is an essential criterion while carrying out duct installation at site. But unfortunately in the referred hospital project, it can be seen at various locations that the main ducts and the branch ducts were hanged randomly without maintaining uniformity in BOD (Bottom of Duct) level.

Fig. 2 depicts such wretched duct installation where the branch ducts are hanging without maintaining any uniformity in their levels. Such misaligned duct installation may develop stress at the duct joints which in

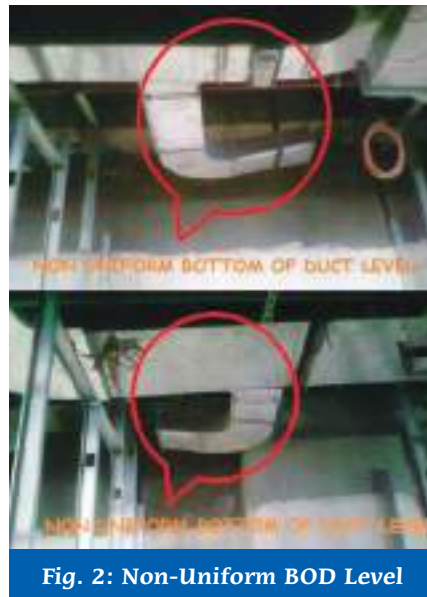


Fig. 2: Non-Uniform BOD Level

turn may cause air leakages. Secondly such kind of unorganised installation of ducts may also disrupt other services in the building.

Observation 3: Within the referred site which was under construction, a most disappointing scene was observed i.e. the emplacement of ducts on the bricks and the wooden junks thrown away by agencies of other services.

Fig. 3A portrays a scene wherein the wooden scraps are made use of for providing supports to the sheet metal ducts.



Fig. 3A: Sheet Metal Ducts Supported by Wooden Debris Lying at Site



Fig. 3B: Sheet Metal Ducts Rested on Bricks & Cable Tray Lying at Site

The former part of Fig. 3B demonstrates a scene wherein the civil bricks are utilized as support for the sheet metal duct and the later part reveals a view wherein it is found that the sheet metal duct is rested on the electric cable tray.

Both Fig. 3A & 3B display a wretched duct installation which is expected to be done by some road side contractor whose financial capabilities are very limited and don't have sufficient skilled manpower to execute the project. The entire fault not only lies with the contractor/sub-contractor but also with the project/site execution team (primarily the supervisors and engineers) who are equally responsible for deliberately letting the poor quality of installation being done at site and thus encouraged the contractor/sub-contractor to follow malpractices at site.

Observation 4: One of the most annoying scenes found at site was the hanging of ducts and hydronic pipe instead of resting on the supports provided. Neither the ducts nor the hydronic pipes were rested properly on the supports.

Fig. 4A exposes off two different vulnerable site conditions where, in the former part, supports are either hanging 50 mm below the ducts and in the later part the supports of the ducts are



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Fig. 4A: Senseless Hanging Duct Supports

missing. It seems as if the supports are provided just for the sake of eye washing.

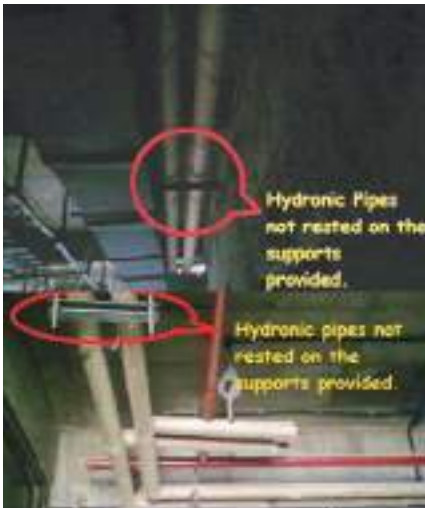


Fig. 4B: Chilled Water Pipes are not Rested on the Supports Provided

Similarly Fig. 4B exposes off the site condition wherein the supports were provided at least 50mm below the chilled water pipes. The gap between supports and chilled water pipes make the supports insignificant because the load of the chilled water pipelines was not taken care of, by the supports provided. Such un-engineered installations were quite prevalent and are common in the referred project.

In Fig. 4B, it can also be noticed that wooden saddles were not provided between the supports and the chilled water pipes.

Observation 5: The intent of insulating ducts and chilled water pipes or the condensate drain water pipe line is to isolate the cold surface from the hot-moist ambient air. Isolation is done because whenever the cold surface of duct or pipe line comes in contact with the hot-moist ambient air, condensation of moisture present in the hot ambient air will start to take place.



Fig. 5: Partly Insulated Metal Support in Contact with Cold Air Duct

Fig. 5, shows a picture of the partly insulated duct support positioned in contact with the duct surface. By doing this act, there will always be a chance of condensate formation on the duct supports due to the difference in dew point temperature and the ambient/return air temperature. Such filthy installations are put into practice because of the ignorance, negligence, indolence and idiocy of the project/site team, who bear an uncared and casual approach towards the quality of installation works.



Fig. 6: Gap Between Two Flanges of Ducts Where Air Leakage Occurs

Observation 6: It was a common observation at site that the pre-fabricated ducts having TDF flanges were not crimped with clits and left the gap unclosed between two adjacent TDF Flanges. At few places it is also observed that gaskets were not provided between two adjacent TDF flanges.

If in case the crimping clits are not available at site, then the TDF flanges could have been bolted by maintaining a distance of 6" between two consecutive bolts. In Fig. 6 the gap between adjacent TDF flanges can be seen from where air leakage originates and this air leakage contributes cross contamination of air. In critical projects like hospitals, cross contamination of air has an adverse effect on the life and health of the patients whoever gets admitted in the hospital.

Observation 7: The purpose of installing a valve in a pipeline is to control the flow of fluid by throttling it. A valve can operate and function only if it is accessible and sufficient coverage is available for the free movement of its spindle/handle. A valve should always be installed at a reachable location, from where it can be operated capably.

Fig. 7 shows different glimpses of the same scene viewed at different angles. Chilled water pipelines are passing out of a civil shaft and ball valves are provided amid of the wall where civil opening is provided. After the civil opening on the wall will be packed up, both the valves will be embedded in the wall and hence the valves will not be accessible whenever the system calls for maintenance. Such an uneven quality of installation is expected to be done by unskilled workmen. These unscientific installations are mostly accepted by sightless supervisors and get certified by spurious engineers.

Observation 8: Mostly it is observed that the discharge side opening and suction side opening of a pump is smaller in size as compared to the pipes connecting to them. To match the size difference between the pipes and the opening of the pump, enlargers/reducers are used. As a standard engineering practice, pump manufacturers recommend to put in the following types of enlargers/reducers.



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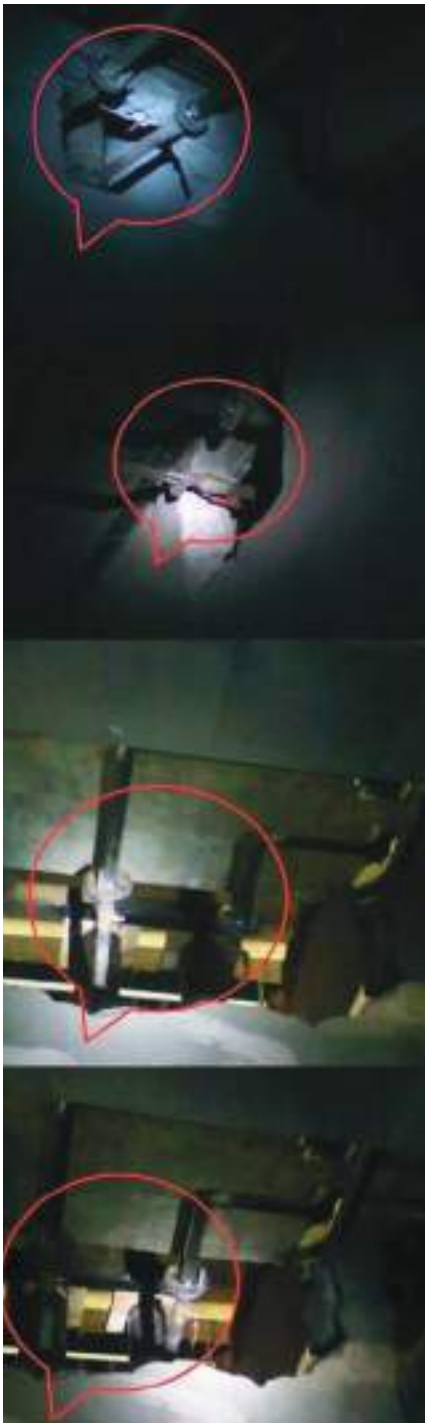


Fig. 7: Valves Provided on Water Pipeliness at Unaccessible Location

- If the discharge of pump is in vertical position then concentric enlarger is recommended to be installed. (as in case of end-suction pumps)
- If the discharge of the pump is in horizontal position then eccentric enlarger is recommended to be installed. (as in case of horizontal split casing pumps & vertical inline pumps)



Fig. 8: Reducers/Enlargers at Pump Suction & Discharge

- Since the suction of the pump is mostly in horizontal position and hence eccentric reducer is recommended to be installed.

The length of an enlarger/reducer has its own significance which is unknown to most of the Indian professionals working in HVAC&R field.

If the length of the reducer/enlarger is insufficient, then it causes turbulence in the fluid which contributes to more pressure drop in the hydronic circuit. Cavitation occurs due insufficient length of reducers at the pump suction. The simplicity of calculating the length of a site fabricated reducer/enlarger is also anonymous to most of engineers. Fig. 8 publicises such a senseless installation of reducers/enlargers at pump suction/ discharge which was also one of the appalling outlook in the project.

There were numerous other observations on this project which are not covered in this article like using of undersized threaded rods, using of undersized MS angel supports etc. All the above mentioned observations express the restrains in HVAC&R segment.

Unlegislated Method of Installation at a Legendary Project

This article also emits light to uncover the howler at country's legendary International airport project and exposes the competency level of present generation engineers working in HVAC&R sector. Hopefully after reading this article, it will be apparent to the readers how the HVAC&R industry is crippling for its survival.

Case – 1: Any electrical panel whether a starter panel or a main distribution panel should always be located at a place far away from source of water. At times the designing team lacks a vision for the future consequences and propose for a disastrous design without proper coordination with other services functioning on the same project. The thoughtless act of designing team may sometimes prove to be fatal.

One such kind of disastrous design was perceived very recently at one of the project where an electrical distribution panel was installed underneath the ducted split indoor AC units. Neither the design engineer from HVAC&R service nor the design engineer from electrical services coordinated with each other and without proper coordination among themselves submitted their design proposals individually. The MEP project coordinator hardly showed any keenness to check the feasibility or the complications of installation for all the services on the project and simply approved the designs and drawings.



Fig. 9: Electrical Panel Positioned Underneath Two Indoor AC Units

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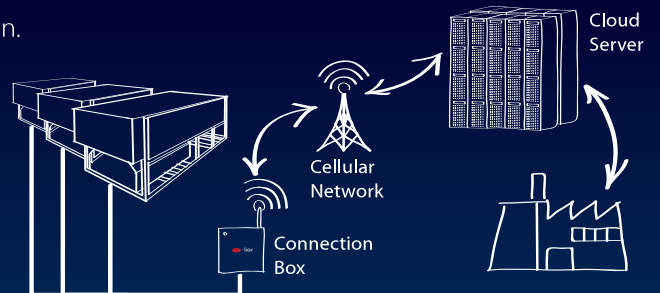
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The consequences were seen after the ducted split AC units were commissioned. The condensate water settled on the surface of the drain pan of the ducted split AC units started dripping on the electrical panel positioned just underneath the AC units. Fig. 9 presents such a kind of view. There was 100% chances to cause an electrical accident if the electrical panel would have been electrically charged or commissioned by then. However all the concerned team members got up from their sleep at that instant & the electrical panel was relocated to a new place.

Case – 2: Approach towards power savings have become a fashion now a days for every customer/client. Even though if the customer/client is unable to en-cash the power saving facility provided for the system, but it is a matter of pride for them to have such a facility in the project. Variable frequency drives are considered to be the best handy equipments for energy saving. In reality the contribution towards the power saving is governed by its proper installation and its right application. Logically a variable frequency drive regulates the speed of a fan motor or a pump motor based on the analog input signals like temperature, pressure etc., it receives through the sensors. In case if the temperature sensors or pressure transducers are not installed in the system or not connected to VFD, then the logic control of the VFD has to be programmed to function at a set frequency. The worthiness of variable frequency drive gets exterminated if it is strained to function at a set frequency.

Fig. 10 shows both correct and incorrect configuration of a VFD system. In the former part, although pressure transducer is provided in the system but its connectivity with VFD is missing. In such a case VFD will not receive signals

to function sensibly. In the later part pressure transducer is provided and connected to VFD. Former part of Fig. 10 is prominently visible at almost all sites. Particularly at this International airport project all the VFD were installed just for the sake of eye washing & regrettably not functioning as desired. Perhaps in the present age, HVAC&R Project engineers don't have sufficient knowledge nor do they have a better understanding about the exact functioning of variable frequency drives.

Chaos in a Green Building Project

This article also focuses on the mis-

concepts about green buildings. In India, so far the government has neither laid down any mandatory rule to have a green building certification for any project nor does the government have any legislative body to promote green building projects. The most amusing fact is that those consultants and principle contractors who are keen to work on green building projects are also unaware of the basic requisites for a green building project. This article uncovers a hidden fact of a semi-government (public sector undertaking) office which was aspired to be a green building project. The intent of the

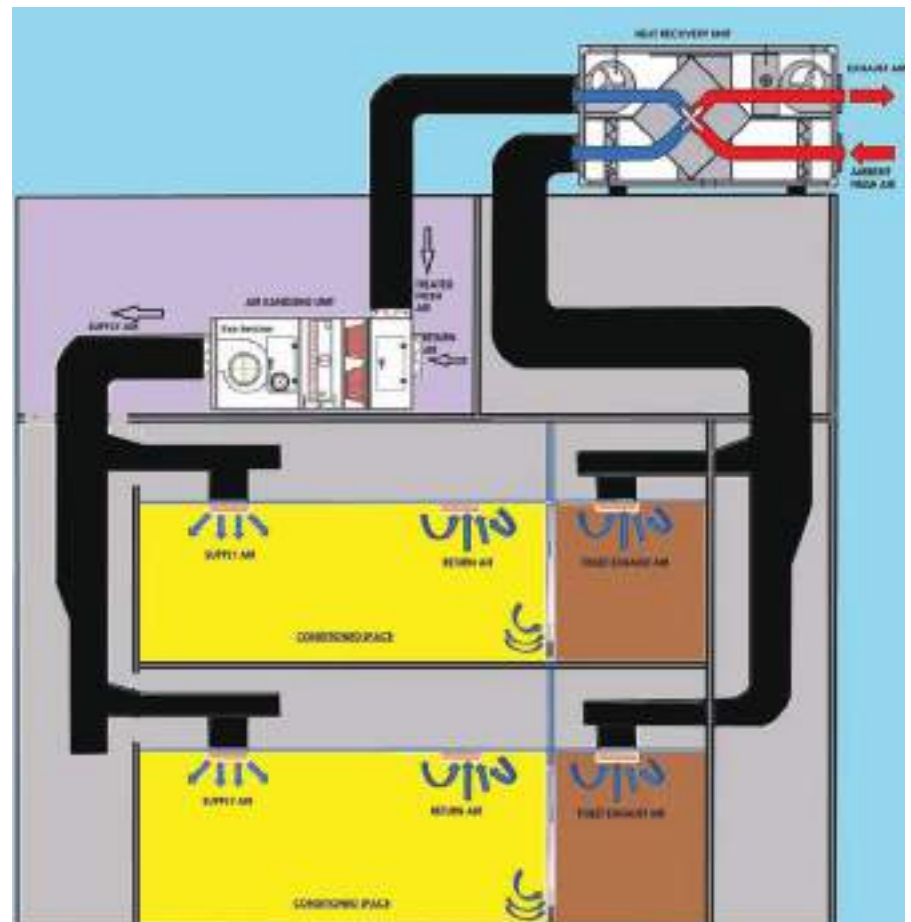


Fig. 11A: Ideal Heat Recovery System

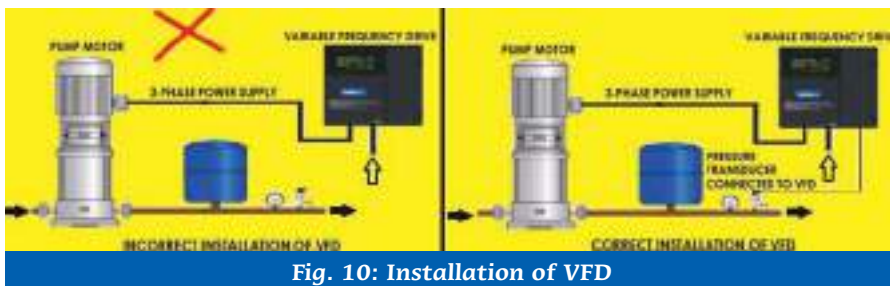


Fig. 10: Installation of VFD

design was to save energy by recovering waste energy and utilize the same energy by recycling. The technical team working on that project proved about their imperceptive participation by shaping the project into muck.

The purpose of using a heat recovery unit is to transfer the heat

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from ambient fresh air to the cool exhaust air and thus to precool the ambient air before delivering it to the TFA (Treated Fresh Air) unit. Basically a heat recovery unit acts like a heat exchanger that transfers unwanted heat from fresh air which is at higher temperature to the lower temperature exhaust air before its disposal. The most commonly used heat recovery units in HVAC&R projects are configured either with heat recovery wheel or heat pipes. The scheme for energy saving by using a heat recovery unit can be successful only if the system is assured to be completely shielded.

Fig. 11A shows a typical heat recovery system installation wherein supply air duct, exhaust air duct & treated fresh air duct are insulated to avoid transfer of heat from the surroundings.

There is a common mindset of imprudent working professionals in

HVAC&R industry that exhaust air ducts are not worth enough to be insulated. This irrational thought causes the heat recovery system to fail. The same incident occurred in the said project wherein insulation was not considered crucial for the exhaust duct carrying cool air. This slip germinated from the very initial stage when the consultant didn't measure the importance of duct insulation while designing the entire HVAC&R project. Since insulation of exhaust air duct was non BOQ (Bill of Quantities) item, hence the contractor didn't act judiciously to raise a query seeking information on the same subject matter nor has any engineer involved in the project took efforts to rework on heat load calculations.

Fig. 11B shows the final view of entire heat recovery system wherein neither the exhaust air duct running from the toilet to the heat recovery unit is thermally insulated nor the

treated fresh air duct running from the heat recovery unit to air handling unit or TFA is thermally insulated. The concluding upshot was a total system failure in terms of energy recovery which was never understood by the client/customer.

Clients/Customers usually don't have any acquaintance about technical aspects of a project nor do their representatives have. Consultants hardly or rarely visit the sites during ongoing stage of the project and never make their presence for witnessing the system performance at the time of commissioning HVAC&R system. So the whole and soul liberty lies with the contractors and their sub-contractors to take the project for a drive. The poor client/customer of the project is neither aware of the green building concepts nor aware about its exact functioning post commissioning, but is very much glad to own a heat recovery system on the project.

Designing of Kitchen Ventilation System

A kitchen ventilation system basically consists of an exhaust air fan/blower and a fresh air fan/blower. The basic function of an exhaust air fan/blower is to extract the air from the kitchen. The purpose of extracting air is:

- To remove the food odours from the kitchen and.
- To extract the heat generated by fumes via kitchen hood and dissipate it into open air.

Similarly the function of a fresh air fan is to infuse fresh air in the kitchen and thus compensate the air removed by exhaust air fan/blower. The transition of exhaust air and the fresh air dilutes the intensity of the odours and dissipates the heat from the kitchen. Since the air vented out is mostly saturated with oil mist and hence it has to be sieved by installing a scrubber in the exhaust air track.

Here is an annoying case of a kitchen ventilation system provided for employees' canteen area in a factory, wherein the client/customer has given utmost importance to cost rather than considering the technical aspects of the project and thus omitted the scrubber

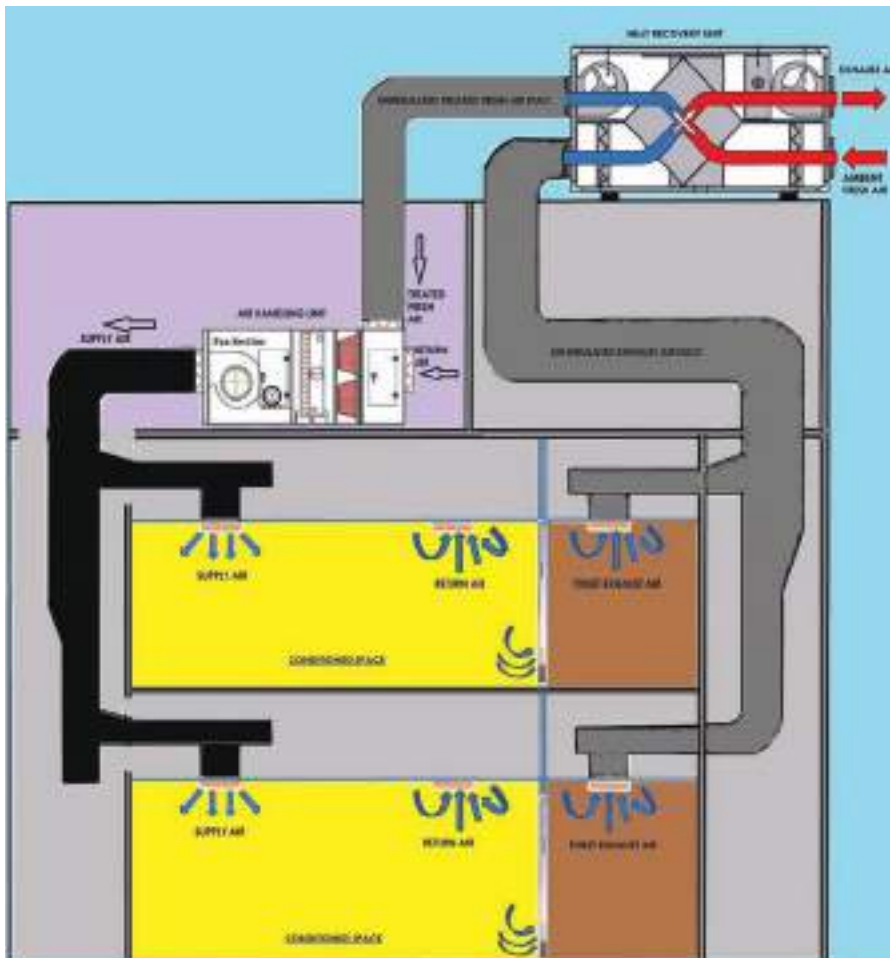
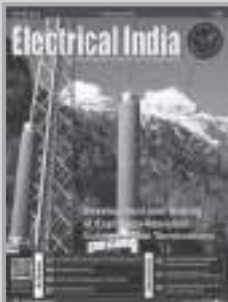


Fig. 11B: Heat Recovery System with Un-Insulated Ducts



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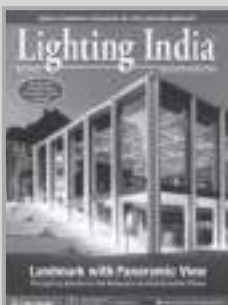
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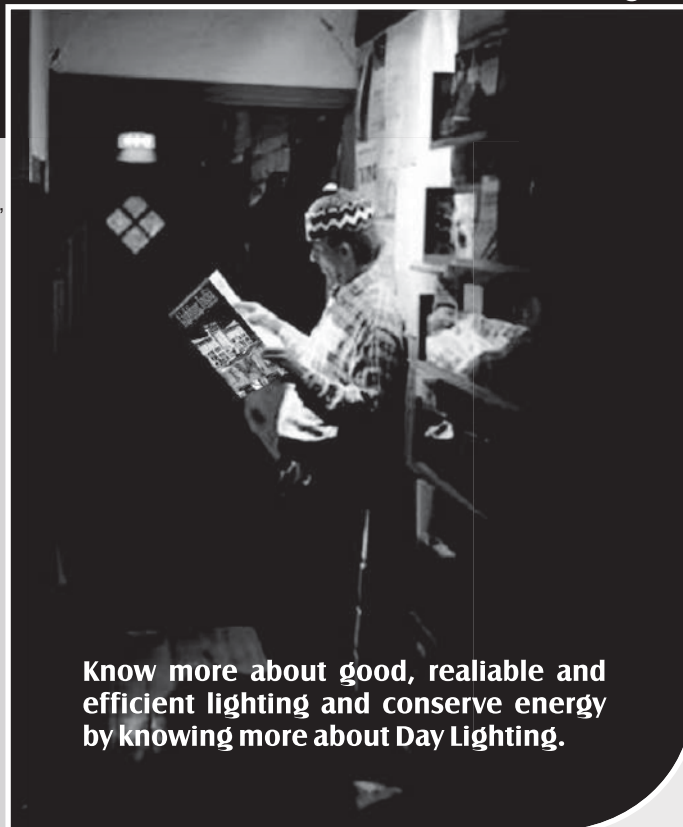


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from the scope of work. The unrealistic sales team representing contracting company didn't apply their precious brain to think technically for incorporating the alteration in the system from design outlook to offset the exclusion of scrubber. The contracting company's sales team proposed their commercial offer by considering cabinet type DIDW centrifugal fans/blowers for fresh air side as well as for exhaust air side.

In Fig. 12A, two different cabinet type DIDW centrifugal fans/blowers are shown wherein the complete fan assembly in association with fan motor and belts are positioned inside cabinet. In a cabinet type DIDW centrifugal fan/blower the exhaust air carrying oil mist always remains in contact with the belt as well as with the motor. The oil mist when settles on belt surface causes the belt to slip and this in turn reduces down the air flow rate followed by regular maintenance calls. Moreover the oil mist gets settle down on the inner surface of the cabinet and aggravates the situation during the course of maintenance.

In Fig. 12B, two open type SISW centrifugal fans/blowers are shown wherein fan motor and belts are positioned in such a way that exhaust air carrying oil mist will never come in contact with belts, pulleys and motors. Based on the past experience and engineering case studies on kitchen ventilation system it is always strongly recommended to install SISW centrifugal fan/blower on exhaust air side.

In India, the tendency of sales professionals is always to dupe the client/customer and thus grab the orders. This tendency is commonly prevalent in HVAC&R field. It is easy to con a customer only for a couple of times, but to be exultant at all times will never work for a long term business and professional relationship in the market.

All the above cases and observations covered in this article are based on true facts which the author has come across very recently within past two years. Despite of acquiring a thorough knowledge and getting acquainted up



Fig. 12A: Cabinet Type DIDW Centrifugal Fans/Blowers



Fig. 12B: Open Type SISW Centrifugal Fans/Blowers

with sophisticated technology, HVAC&R professionals are still used to work like laymen in their own field. Bureau of Indian Standards cover most of specifications related with the draft finalised by Refrigeration and Air Conditioning sectional committee. A few BIS codes that are indigenous and are supposed to be followed in HVAC&R industry are:

- IS 655 for specification of air ducts
- IS 11561 for code of practice for testing of water cooling towers
- IS 7896 for outside design

conditions data for air conditioning in various Indian cities.

- IS 659 for safety code for air conditioning.

Unfortunately, there may be only a few professionals who may be aware of BIS codes established for air conditioning and refrigeration system. The present culture in Indian market is to endorse and promote the guidelines and specifications laid down as per foreign standards like SMACNA etc. In India, there has always been a trend to articulate the foreign guidelines in the contractual documents like SMACNA, DW-143, DW-144.

IS 655 is the only Indian Standard for specification of ducts, mostly accepted in all public sector projects. Otherwise in all private sector projects, there is an approach for non indigenous standards.

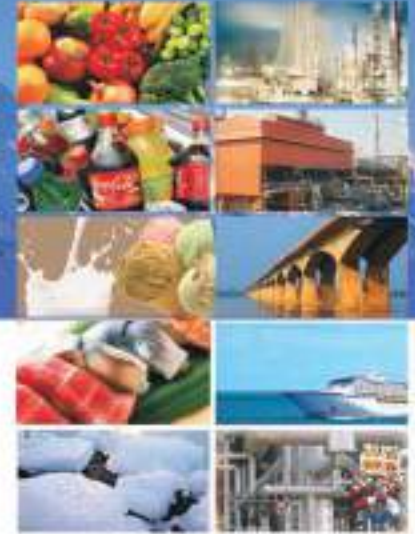
There are a list of various reasons and factors that are responsible for the degradation of HVAC&R industry in India. The list of such reasons & factors is so extensive that a comprehensive paperback is required to cover them all. However the intent of this article is not to criticise the prevailing system in India. The integral objective of this article is to express the concern & create awareness among the working professionals who have emerged newly into HVAC&R industry as well as to all those working professionals who have dedicated their life and career to HVAC&R industry. We as Indians talk a lot but we never walk the way we talk all about. At times the total control may not be in the limits of team working on the project, but the total control lies at a higher management level. Top management of contracting companies must be cautious enough to support their team and enforce them to adapt highly engineered skills. Regular trainings must be imparted to the project team and enlighten them to follow ethics that may bring laurels to the organization/company. The value of a project should be valued in terms of its quality of work, reliability in its system performance and its successful accomplishment rather than feeling conceited on executing a high volume or a large size project. ■

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Nocturnal Cooling assisted Evaporative Cooling System



Nocturnal cooling is an age old technique to cool the structure based on the radiative cooling to the night sky where heat loss occurs by long-wave radiation from one surface to another body at a lower temperature. The nocturnal radiative cooling technique can also cool the water up to 28-30°C in a hot and humid place. This relatively cold water can effectively be used to pre-cool the air in a properly designed finned tube cooling coil unit.

A test facility is developed where a finned tube cooling coil unit facilitates cooling the air followed by conventional evaporative cooling. Results show that direct evaporative cooler clubbed with cooling coil to precool the air attains the temperature drop of the order of 11°C, almost 4°C higher than conventional evaporative cooling with a better control of humidity, in a hot and humid environment. Thus, this environmentally clean and energy efficient system can be considered as an alternative to the mechanical vapour compression systems.

Among the heating, ventilation, and air conditioning (HVAC) systems, cooling systems consume the largest amount of electrical energy. Cooling is an essential issue in air conditioning in warm climates. The issues of global warming, the natural resources depletion, and demand for environmentally-friendly systems have led to a growth in

use of natural green resources instead of conventional systems.

Heat dissipation techniques are based on the transfer of excess heat to a lower temperature natural sinks. Regarding sky, heat dissipation is carried out by long-wave radiation from a building to the sky that is called radiative cooling or nocturnal cooling. The sky equivalent temperature is usually lower than the temperature of the most bodies on the earth; therefore, any ordinary surface that interacts with the sky has a net long-wave radiant loss. Radiative cooling to the night sky is based on the principle of heat loss by long-wave radiation from one surface to another body at a lower temperature.

The sun radiates heat to earth in the day. At night the reverse happens when the warmer earth radiates heat to the cold night sky. Roofs of buildings radiate heat day and night



Dr. Neeraj Agrawal, has Master's and PhD degree from IIT Madras and IIT Kharagpur, in Mechanical Engineering. He is presently Associate Professor in the Department of Mechanical Engineering at Dr. B. A. Technological University Lonere. He has published more than 50 research papers in various Int. Journals.

He is reviewer of many International Journals. The BTech and MTech projects supervised by him, has been awarded 5th, 6th and 9th Bry-Air award, excellence in HVAC&R at national level.



Nilesh Babar, graduated from Karmaveer Bhaurao Patil college of Engg. Satara has Master's degree form Dr. B. A. Technological University Lonere. His area of interest is HVAC&R.



at a rate of up to 75 watts per square meter. During the day, this is offset by solar radiation gains on the roof, however, at night, this heat loss has the ability to cool air as roofs can experience a temperature drop

of 6 to 20°C below ambient. Cooling a building by long-wave radiation to the night sky has long been identified as a potentially productive means to reduce space cooling energy in buildings but the technology has not been commercially available.

Direct evaporative cooling (DEC) is the oldest, and the most widespread form of cooling systems. The underlying principle of DEC is the conversion of sensible heat to latent heat. Through a direct evaporative cooling system, hot outside air passes a porous wetted medium. Heat is absorbed by the water as it evaporates from the porous wetting medium, so the air leaves the system at a lower temperature. The minimum temperature that can be obtained is the Wet-Bulb Temperature (WBT) of the entering air. Indirect evaporative cooling (IEC) has high potential for providing air conditioning demands at low energy costs. An indirect evaporative cooling system consists of two impervious separate air passages, primary and secondary air passages which are dry and wet, respectively.

In the primary passages, outdoor air flow is sensibly cooled without adding water, while the secondary air and water flow in the secondary passages. The surface of the secondary passages is wetted by spray water, so that water film evaporates into the secondary air and it decreases the temperature of the wall. As a result, the cold wall removes the heat from the outdoor air. Consequently, the leaving air from the primary passages has a lower wet-bulb temperature than the entering air. In a two-stage Indirect-Direct

Evaporative Cooling (IDEC) cold air enters to DEC unit after IEC causes further temperature drop, as a result, effectiveness of the systems increases.

It is always good and preferred to maintain the desired room conditions precisely in order to have better thermal comfort. Summer air conditioning systems which are capable enough to maintain exactly the required conditions in the conditioned space, however, are expensive to own and operate. Sometimes, partially effective systems may yield the best results in terms of comfort and cost. Evaporative air conditioning systems are inexpensive and offer an attractive alternative to the conventional summer air conditioning systems in places, which are hot and dry. However, evaporative coolers are not effective in hot and humid environment due to high humidity. Precooling the air can make the evaporative cooler suitable even in hot and humid environment. Precooling can be done in a finned tube cooling coil using nocturnally cooled water as the cooling agent.

Nocturnal cooling

The natural cooling of water at night in a non-insulated open tank by evaporation, convection and sky radiation is



Fig. 1: Nocturnal cooling of the water the open tank

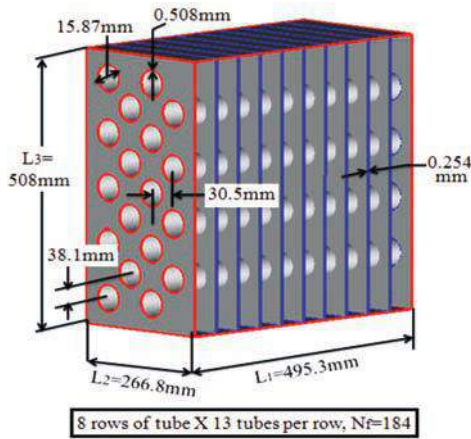


Fig. 2: Geometric parameters of cooling coil



Fig. 4: A typical view of the test facility

shown in Fig. 1. A tank having an open surface area of 15 m² and a depth of 0.5 m is used for the nocturnally cool the water. The water temperature was dropped in the range 5 – 6°C at a hot and humid place. The water loss due to evaporation convection mass transfer cooling was observed in the range 2.5% to 4.13%.

Finned tube cooling coil unit

A finned tube cooling coil unit is designed and developed based on steady flow thermal modeling. Steady flow energy equations and $\epsilon - NTU$ technique are used to model the cooling coil. Aluminum fins mounted on the external surface of the cooper tube is considered for design the cooling coil. The total length of the cooling coil is obtained as 45.71 m. Designed finned cooling coil is shown in Fig. 2.

Nocturnally cooling assisted evaporative cooling system

The experimental test facility facilitates the precooling the air using nocturnal cooling water. The water is stored in a pond cooled by nocturnal cooling and stored in a storage

tank as shown in Fig. 3. The cold water is used in a cooling coil unit as cooling medium to precool the air. The pre-cooled air passes through an indirect evaporative cooler followed by direct evaporative cooler shown in Fig. 3. From different available designs of indirect evaporative heat exchanger, air to air plate type evaporative heat exchanger is used in first stage cooler. Heat exchanger is made up of aluminum plate of 0.5 mm thickness. The outer boundary (duct) is made up of galvanized iron sheet. Direct evaporative cooler consists of number of evaporative pads in series. Three sets of cellulose pad of 50 mm thickness are used in series.

In order to have proper circulation of water throughout the set up, self priming hydraulic pump of ½ hp is used. At inlet pipe of the cooling coil unit rotameter is placed to measure the water flow rate and provision of bypass valve is made to reduce extra flow rate of water. The photograph of the test setup is shown in Fig. 4.

Fig. 5 shows the temperature variation in five consecutive days employing the nocturnal cooling. A comparison of the room naturally cooled water and nocturnally cooled water is exhibited in Fig. 5. It can be seen that temperature drop is almost 2 to 3 degree is higher with nocturnal cooling in comparison to room naturally cooled water.

Fig. 6 exhibits a comparison of the conventional evaporating cooling and cooling coil assisted evaporative cooling. Precooling of air followed by Indirect evaporative cooling is also compared. It can be seen that cooling coil assisted evaporative cooling perform better that other options. The maximum temperature drop achieved of the order of 11 to 12°C in comparison to only evaporative cooling where air temperature drop is of the

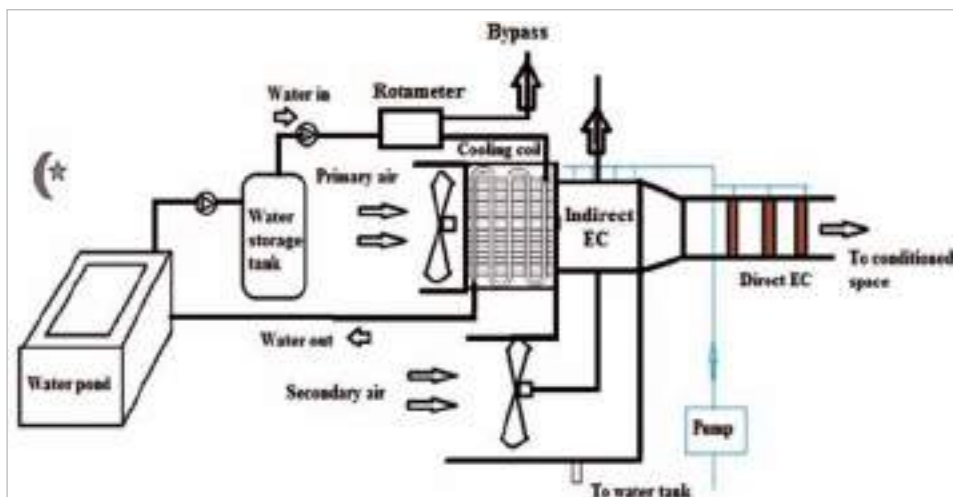


Fig. 3: Experimental setup

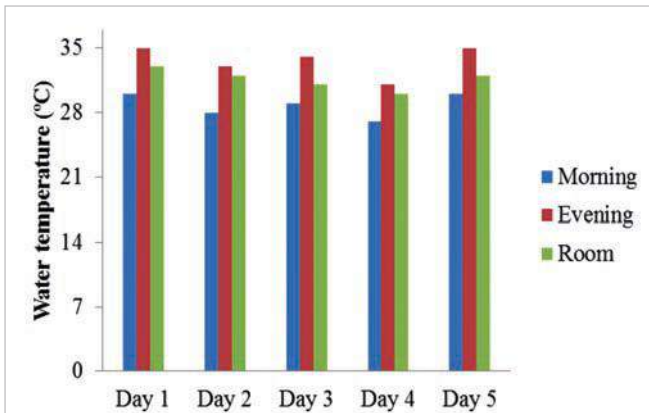


Fig. 5: Comparison of temperature of room and nocturnally cooled water

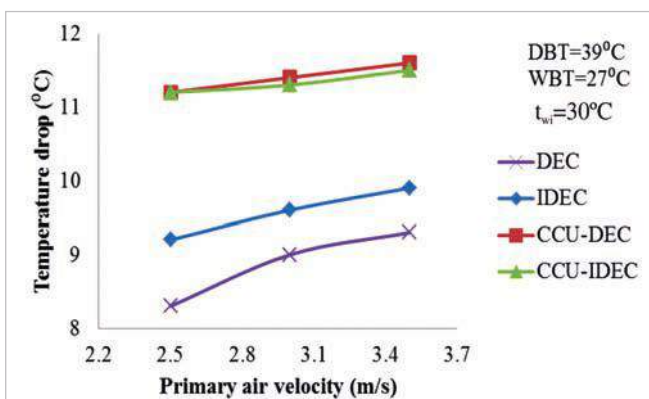


Fig. 6: Performance comparison of evaporative cooling and nocturnal cooling assisted evaporative cooling

order of 8 to 9°C. It can also be seen that in cooling coil and indirect-direct evaporative cooling combination the indirect evaporative cooling system becomes redundant as it does not bring any performance improvement. It shows that temperature drop with conventional direct and indirect direct evaporative cooling significantly increases employing the precooling air using nocturnally cooled water. It is observed that nocturnal cooling assisted evaporative cooling system reduces the air DBT from 39°C to 27.6°C while conventional evaporative cools the air only up to 30°C, almost 3°C higher than nocturnal cooling assisted evaporative cooling system which is quite significant.

Summary

Taking advantage of sky as a renewable source of the passive cooling, precooling of the air in the evaporative cooling system is quite effective and enhances the evaporative cooling performance significantly. The proposed nocturnally assisted evaporative cooling hybrid system which is partially effective yet yields the best results in terms of comfort and cost and can be considered as an environmentally clean and energy efficient system.

Thus, this system can be used as a replacement for mechanical vapor compression systems, leading to decrease in electrical energy consumption. ■

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To transform customer experience by leveraging our operational excellence

V Radhakrishnan, Managing Director - South Asia, Aggreko Energy, in an exclusive interview with **Cooling India** says, we have executed many multi-megawatt power projects (both LV/HV packages) and multi-TR cooling projects with reputed organisations.



You joined Aggreko Energy Rental India Ltd. as a Country Head in 2012 and are Managing Director - South Asia now. What is your major role for Aggreko India? Could you share your achievements so far?

Aggreko, a Great Britain based multinational, has been providing temporary power and temperature control (TC) solutions for over half a century, making us the longest running business in these services. We established our operation in India in 2009 with the acquisition of Cummins India rental arm, and since have built a strong reputation for reliable service delivery of temporary power packages and cooling solutions. As the person charged with building sustainable business for Aggreko, my main focus is on creating awareness of our offering and value proposition, which includes helping customers optimise production through the efficient implementation of interim power and/or TC solutions. While the concept of renting is an upcoming one, it is still not matured in our country; and our mission is to build awareness by educating various industrial and commercial segments and users on the benefits of modular and quickly deployable rental power and cooling solutions.

In India we currently have about 150 MW of power fleet and 4500 TR of cooling fleet. We have numerous installations in the country covering all major industrial sectors, commercial segments and events. So far, we have worked in segments such

as manufacturing, oil & gas, shipping, utilities, mining, construction, infrastructure, commercial buildings, events and other related sectors. We have executed many multi-megawatt power projects (both LV/HV packages) and multi-TR cooling projects with reputed organisations. We are able to meet any customised power and cooling requirement as a single party, owing to the availability of our highly reliable and energy efficient fleets.

Could you explain the customer benefits and challenges involved in providing the 'Cooling rental packages'?

Our cooling rental packages, which we refer to as TC, help customers to minimise potential losses during delivery delays in cooling equipment, emergencies, performance improvements, pilot testing, maintenance



outages, cope-up with seasonal demands, etc. Rental options allow for customers to save on CAPEX while they focus on improving revenue streams, as well as providing solutions quickly that can be scaled up or down according to need - that's the beauty of what we do. We are not a permanent solution, but we do fill a very important gap between the 'having' and the 'not having' - giving customers the option of choice when they face difficult decisions. We will come in and assess a customer's needs, design a be-spoke solution and mobilise and install the solutions, quickly. In addition to this, as a global company we practice the highest standards of quality, health, safety and environment (QHSE), meaning a customer in India can expect to receive the same level of service as a customer in Canada.

We take pride in the fact that not only do we design and manufacture all our own equipment, but also provide our customers with 24X7 on the ground support, making our turn-key offering a unique one. Our biggest challenge, in India is to overcome the mind-set that 'owning' equipment is cheaper than 'renting'. There are so many indirect costs attached to an option of 'owning' equipment. While owning has its long term benefits, in the short to medium term, during leaner times or for emergencies, rental options make more sense. Continued efforts in educating potential users and sharing our global experience is set to change things in the market over a period of time.

For creating customised cooling solutions, what strategy do you apply?

When it comes to offering the cooling solutions, by and large, there is no ready-made solution available. We need to first understand the situation and various internal and external factors which would determine the solution. Understanding the customer pain is key for designing the right solution. Having been in the business for as long as we have and with operations in over 200 locations around the world, the success of Aggreko speaks for itself. With an impressive portfolio

of clientele, much of which is repeat business, Aggreko's reputation as a reliable partner is what sets us apart from the competition.

We launched our customised cooling solutions in India just over couple of years ago, after it was apparent that there is a real gap in the market as far as quality rental cooling solutions are concerned. We are pleased to say that in this short period of time, we have successfully executed jobs in variety of industrial sectors as well as in commercial segments and prestigious events like Vibrant Gujarat, Auto Expo, Aero Show, MCHI, to mention a few.

Could you explain your company's product range, and cooling solutions, offered?

We specialise in two main areas - power packages and temperature control (i.e. cooling) solutions. Our products are purposely built for rental applications and our temporary installations challenge the quality of permanent installations in terms of efficiency, safety and performance. We provide state of the art, containerised power generating sets designed to operate on diesel, natural gas or heavy fuel oil along with the complete accessories like transformers, cables,

Aggreko plc is the world leader in the supply of temporary power and temperature control solutions. Aggreko employs over 6,000 people operating more than 200 locations. In 2013 the company served customers in about 100 countries, and had revenues of approximately GBP 1.6bn (USD 2.5bn or Euros 1.9bn). Aggreko plc is a member of the FTSE-100 index, and is headquartered in Scotland. Aggreko provides power and temperature control solutions to customers who need them either very quickly, or for a short or indeterminate length of time.



Aggreko's modular cooling tower rental solution

power distribution panels, etc. We also provide load bank packages with accessories for testing power systems. Our TC fleet is extensive and includes air-conditioners, chillers, cooling towers, air handlers, heat exchangers along with complete accessories like buffer tanks, pumps, hoses, couplings, etc. Our cooling towers are also modular and quick to install. These are packaged in 12m (40 feet) container frames for enhanced safety and ease in operations. We believe that our cooling fleet is set to bring a paradigm change in the way industry, currently, looks at cooling during capacity augmentation, maintenance outages and dealing with the emergency situations to reduce down-time and production losses.

While our products are standardised, modular and custom built to allow for easy mobility, each solution is customised to address the customer's issue efficiently and reliably. Take for example our chiller package at an event. We look at fresh air load and run psychrometric profiling of the inlet/outlet air stream as well as human density before drawing up a solution that will provide the customer with the most optimal solution.

In other regions like North America, we have the services called APA (Aggreko Process Assessment) and APS (Aggreko Process Services) - something we are looking to introduce in India in the near future. In general terms, APA & APS focus on cooling plants - taking a thorough and detailed look at how the equipment functioning, and then counselling on where improvements can be made. Apart from a valuable prognosis, it provides solutions in production terms on any of your process shortfalls. The assessment will enable customers to accurately and effectively plan production by knowing exactly what the capabilities of the plant are.

What major attributes would you suggest for expansion of project business incident to capital goods industry in cooling sector?

While there are overall positive business sentiments, current volatile market conditions mean that - the capital goods sector is going through tough times and cooling equipment is no exception. However, once the country's infrastructure and industrial sectors starts to benefit from planned investment, growth will inevitably follow and cooling providers will also stand to gain. Further, much of the cooling equipment in circulation is old and inefficient, putting businesses at risk of production loss, especially for industries that count on this equipment such as process industries like food and beverages, etc. Industries looking for a change, who cannot afford the investment, can look at testing new concepts using rental equipment so that they are ready to take decisions fast when the economy fully revives.

How you focus on the various QHSE standards? How they are being pursued by your company to command major market share in India?

We are in the business of power and cooling rental solutions. Customers often require these



High standards of QHSE at Aggreko's chiller rental solution

solutions on an urgent basis. It is critically important for Aggreko to make sure that we provide the perfect solution to ensure emergency situations do not escalate further than necessary.

QHSE is of primary concern to Aggreko due to the nature of business, which involves heavy machinery, electricity and various fuels. Aggreko uses daily Key Performance Indicators (KPIs) including Frequency Accident Rating (FAR) to measure the ongoing effectiveness of our safety programs. Safety for life, an all-encompassing employee safety program is an integral part of all of our operations, in all parts of the world.

Our exemplary practice of QHSE standards is one of the reasons, we are the preferred service providers for events like Vibrant Gujarat, Aero Show, Auto Expo, etc in India and mega events such as the Olympics and FIFA World Cup in the global market. When it comes to industrial sectors like manufacturing, oil & gas, etc., QHSE standards are imperative.

How do you cater to all India requirements, presently?

India has a huge geography and for a service company, covering the entire country is one of the challenges. At present, we have three well equipped depots in India. These are located at Manesar, Pune and Chennai. In addition, we have two parking lots at Hyderabad and Vizag.

Moving forward, we are looking to create a 'hub and spoke' service model, since awareness as well as requirements of temporary power and cooling is increasing, every day. To understand customer requirements effectively, we have a sales network in about fifteen major cities in India.

What is your vision in the next three years?

Our vision is to transform the customer experience by leveraging our operational excellence, product quality and our unique and time tested service framework, while we strive to serve every industry covering all applications.

Our products are purposely built for rental applications and our temporary installations challenge the quality of permanent installations in terms of efficiency, safety and performance. ■



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Solar Thermal and Biomass Energy based Hybrid Cold Storage for Rural Applications



India is second largest producer of fruits and vegetables in the world. Horticulture provides 6.5% GDP of the national economy, 13% of employment opportunities, account for more than 9% of exports.

The suicide committed by farmers on large scale since last decade is a very serious issue. Waiver of loans or electrical bills is not at all an effective solution to this disaster. The fact is that the farmer is exploited by brokers and even if consumer is paying high rates the benefit is not passed to farmers and he is colonized. This is mainly due to the Agro produce being highly perishable. Proper decentralized storage facilities nearest to the farm and at lowest cost with non dependency on grid supply is the basic need of Agricultural sector. This will not only improve the economy of the farmer but also of the nation.

It is most unfortunate fact that more than Rs 60,000 corers worth agro produce is lost due to post harvest handling and proper storage.

Solar Energy is most Clean, Free and For Ever Energy, which can be tempered as Future Energy to save our mother Earth. It has two components –

- Solar Thermal and
- Solar Light, which can be converted to electricity by photovoltaic technique.

At present Solar Thermal Energy can be harnessed in most effective and economic ways for various applications. Lots of effort have been put in worldwide for using Solar Thermal Energy for cooling application but the poor COP has been the major constraint making it economically non viable.

The cold Storage has to operate round the clock and throughout the year. The Solar head is not available during non sunny hours and during non sunny days of rains or clouds. Hence it is essential to provide backup based on green fuel. In our country huge waste in the form of bio-degradable or bio-combustible form is easily available. This can provide not only back energy sources but also mitigate waste management problem at cheapest cost.

My objective of this R&D was aimed



to make it having COP above 1.26 which will make it acceptable on Social, Economical and Ecological fronts.

In this article I present use of Solar technology, which is not only clean, hygienic but also confirming for CDM of Kyoto Protocol.

Outstanding Merits

- Novel concept using solar thermal energy & biomass (bio-degradation or gasification) for cold storage.
- Operates @ cop above 1.26.
- No compressor - no costly maintenance
- No CFC - Effective step to protect ozone depletion.
- Eco-friendly design.
- Best confirming to crop contamination control.
- The system offer safe storage of agro produce without grid support.
- Payback period – less than four years
- Wide range of capacities - 40 to 10000 tons.
- Best RH control.
- Best contributing to mitigation of national energy crises.
- Contributing to saving of fast depleting fossil fuels.
- Contributing to saving of valuable foreign exchange.
- Helps in stopping use of child labour,

Dr OmPrakash G Kulkarni is recognized as Scientist at Global level Renewable Energy field and as Inventor of World's first Solar Thermal/ Renewable Energy based Cold Storage/ Refrigeration system. He is Expert Advisor invitee to MERC, GoM, Ex. BOS member on Electrical Engg./ E & TC and Instrumentation Science, Referee for PG at Pune University. Also member of Governing body of more than 13 Engineering Educational Institutions.



- who are engaged for logistic activity.
- Wide acceptability & well accepted process support to the to Agricultural producer, boosting their standards at Global level.
- An Effective service to world by way of energy conservation, protection of ecological balance, savings huge foreign exchange involved in Coal and Petroleum imports.
- The present system can be modified for Agro - Industrial for Precooling or Cold Storage applications based on Renewable Energy source.
- The unique & most effective step by Dr. OGK in promoting use of RE.
- Substantially large savings on fuel cost.
- No generation of Green house gases.
- Superiority in process standards based on Renewable Energy source meeting the Global need.
- Achieving healthy & sound financial gains.
- System life is much higher than existing one.
- Most efficient & cost effective design.
- A great opportunity for upliftment of Rural life standard as an effective solution to cause of farmers' suicide.
- Generation of employment opportunities to Rural population at local level.
- Effective solution to problem of Urbanization.
- 16 sq mtr to 32 sq mtr Scheffler or 81 to 225 sq mtr size Dr OGK's Heliostate concentrators can be used to harness Solar Thermal Energy.
- Best solution to Waste Management at cheapest cost and the backup at lowest cost.

Demerits of Present Process

- Presently Electrical energy is used as common source of energy for Cold Storage application. The compressor and the Air Handling Unit are very

high energy consuming and maintenance prone components of conventional Cold Storage system. It also uses CFC - an ODS which is main cause of Ozone depletion. Hence there is immense need of some Renewable Energy based effective system as an alternative to above.

- The huge demand of Electrical Energy by such system calls for substantial load on Generations end as the Transmission and Distributions losses are almost 43% or above. At many places Heat recovery based or Fossil Fuel based steam or hot water Vapor Absorption based (VAC) system is used for Cold Storage application. But the main drawback is very poor COP say 0.26 to 0.93. At such low COP system can not be converted to Solar based. Again in this also Central AHU is a high energy consumption & maintenance prone component.
- In addition to above the due to central AHU spreading of contamination is a serious problem. This becomes issue of concern mainly spoilage of crops and this is burning issue faced worldwide.
- This in turn calls for burning of huge coal or Diesel or Naphtha stocks at Thermal Power Stations. The fast depleting stocks of fossil fuel are to be conserved for future. Burning of fossil fuel lead to emission of CO₂, NO_x and other GHGs.
- In case where wood is used as fuel for boilers it adds to severe tree felling and in addition to deforestation the Green vegetation acting as Carbon sink is fast depleting.
- All such tampering with nature will endanger the entire living species on this mother earth due to global warming.
- Serious problem of CO₂, NO_x, SO_x generation leading to Green House

Gas effects and Global warming, Ever increasing costs of these fuels., Contamination of process material, unhygienic conditions, un – cleanly work environment, health hazard to operators etc. are additional draw backs of the present system.

- Normally such cold storages are a far distance from actual producing farms. At present largely child labour is used for managing logistic of the agro produce.
- The maintenance of existing system is very huge task, which needs a permanent maintenance employee and involves heavy recurring cost.

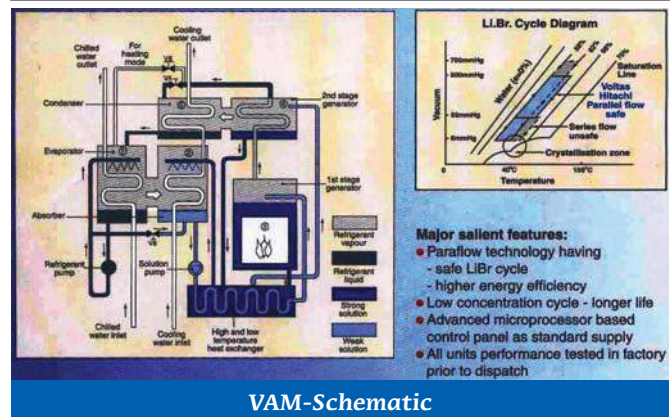
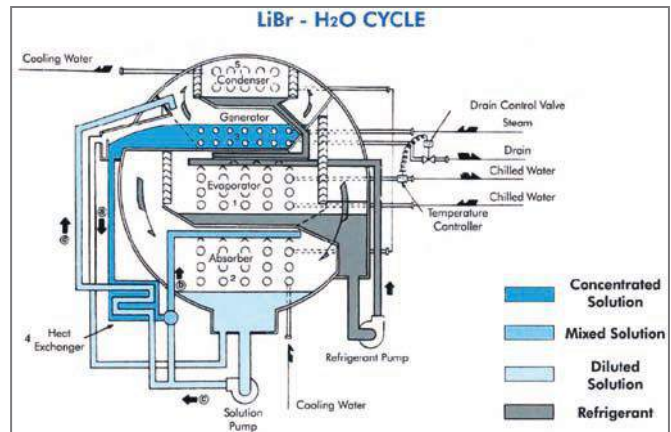
Objective of the Project

- To establish full-scale demonstration project for successful application of SOLAR Parabolic concentrator based Solar and with bio mass backup based Cold Storage System.
- To achieve substantial savings on Fuel cost.
- To avoid generation of Green house gases.
- To achieve Eco-friendly operation.
- To avoid Contamination of Agro produce, unhygienic conditions etc.
- To Re-gain quality status in Local & Export market with EMS standards.
- To achieve superiority in process standards based on Renewable Energy source meeting the Global need.
- To achieve healthy & sound financial gains to farmers.
- To achieve minimal maintenance cost.
- To increase system life.
- To increase efficiency of Renewable Energy based cooling system.
- To achieve justified IRR with quick payback period and fast revenue generation.
- To achieve wide acceptability & well accepted process support to the farmers using Cold Storage System, boosting their standards at Global level.
- To offer service to mankind by way of energy conservation, protection of ecological balance.
- Avoid the suicides committed by farmers due to financial crises.
- To achieve implementation of objectives adopted by Kyoto Protocol.

Functional Details of Project

Solar Cold Storage is done by an Eco friendly Refrigerant vaporization using Solar Thermal energy concentrated by novel SOLAR concentrators. This vapor at high pressure is then cooled during which the absorbent is separated out and liquefied refrigerant is obtained. During this process heat is exchanged with water, generating hot water. Chilled water at temp below 5 deg. C or brine at – 5 deg. C is generated by using this liquefied refrigerant. Now the refrigerant is recycled for next heating. In this process the refrigerant start evaporating. Further again the refrigerant goes to next cycle of heating by Solar Thermal. Generally the refrigerant is heated directly. But it can be heated through any indirect method using Thermic Fluid or vapor.

The entire system is monitored, controlled and Governed by using micro-controller PLC based intelligent system with



special tailor made user friendly 4 GL RDBMS based software with fuzzy logic.

Considering the non-Sunny days and the difficulties in using fossil fuel as a back-up fuel due to regulatory norms, our R&D team have successfully developed unique Gasifier by using combined technology of gasification and bio-degradation mixed with other agricultural waste. In this method some part of waste material gets converted into charcoal after extraction of fuel gas. The charcoal can be formed into brickquets, which again can be used as low polluting fuel. In bio-degradation, methane is obtained as fuel and the biodegraded material can be used as rich manure for crops. Thus apart from getting fuel we get manure making the total process eco friendly to the best possible extent.

System Components

- Solar Concentrators.



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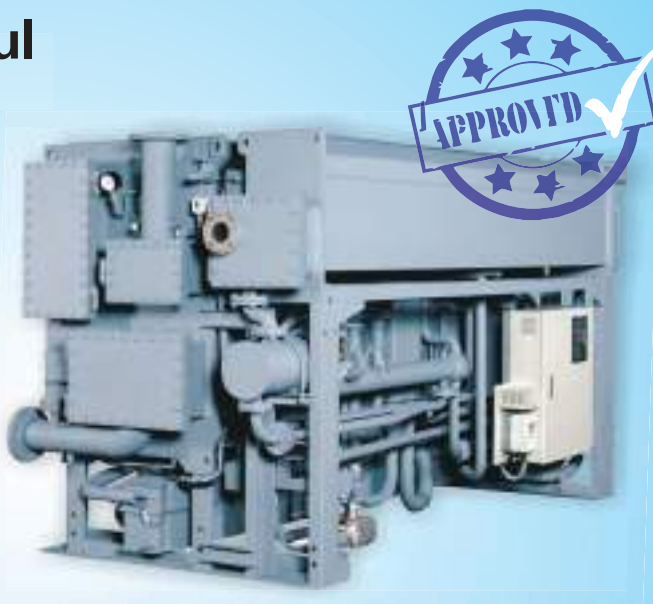
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- Cooling tower.
- Hot water generator.
- Instrumentation, protection control and monitoring panel.
- Bio massed based backup system.
- Back pressure turbine for power generation. The discharge of the turbine can be admitted to VAM.

Scope of Work

By the Consultant

- Concept to commissioning design, monitoring, validation, documentation.

By the manufacturer

- Initial site survey and data finalization.
- Design of the suitable Solar system, Preparation of drawings with installation details.
- Submission of proposal to MNRE for subsidy.
- Manufacturing of the system as per design.
- QC testing.
- Transportation to the site.
- Installation and commissioning at site.
- Testing and trial runs.
- Certification/ validation from consultant at different stages. Training and handing over to the user.

By the user

- Providing the maximum data to the manufacturer/ consultant.
- Preparation of site for installation as per directions of the system manufacturer.
- Assisting at the time of installation and commissioning
- Dedicating concerned staff for training and operation of the system.
- Using the system as per directions of the manufacturer and keeping the log book of activities as per MNRE and Kyoto protocol standards.

Future Plans

Plans are ready for establishing Solar Thermal & biomass backup base for Pasteurization of Milk etc. Parties interested in establishing such projects may contact the Author. ■

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INSUsound: A flexible, open cell foam, made from melamine resin, ideal for sound insulation.

Solar Refrigeration Technology for On-Farm Transient Storage



A long view of the system set-up at roof of an existing building at Anand (Gujarat)

Most of the cold storages in India are typically located either in cities or near the market hubs & are used for selected fruits/vegetables for periods normally extending upto a few months.

The fruits and vegetables from the fields are straight away sent to any of the marketing centres in the neighbourhood and sold at the prevailing rates. Transient storage of the horticulture produce in the production catchment may considerably enhance farmers income. Renewable Energy based transient storage of the horticulture produce in the production catchment appears feasible. India is blessed with solar energy (5-7 kWh/day for 200-250 day/year). Sardar Patel Renewable Energy Research Institute (SPRERI) has developed a solar-biogas hybrid transient storage system funded by the National Agricultural Science Fund (ICAR). Under this project, a pilot plant has been set-up at incubation centre building, Anand agricultural university, Anand. The system can store about 10 tonnes of horticultural produce for a period of up to four weeks at constant temperature of 10-12°C.

Transient storage facility configuration

The system consists of five subsystems i.e

- Solar thermal collector;
- Biogas plant;
- Vapour absorption machine;
- Solar PV power plant; and
- Cold chambers.

The schematic of the system is shown in Fig.1.

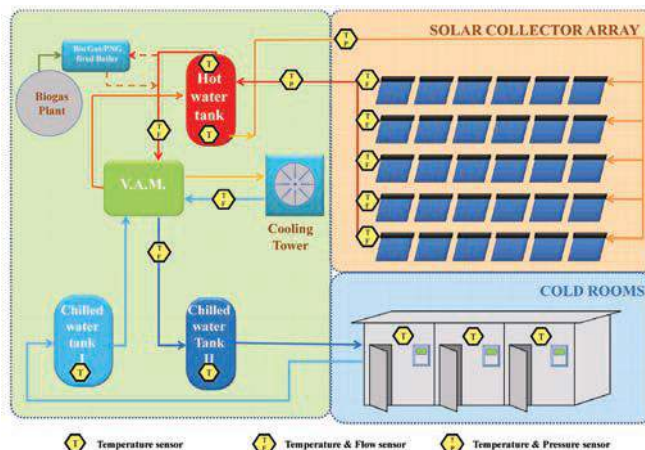


Fig. 1: Schematics of the solar-bio gas based transient storage facility

Solar thermal collector

Simple and high-quality non-tracking solar thermal collector array consists of 5 loops each comprising 9 collector modules. Each collector consists of 20 heat pipes immersed in evacuated tubes of 58 mm diameter and 1.8 m length. The condensing ends of all the 20 heat pipes are connected by a header. These ETC tubes with heat pipe offers an unique advantage of raising temperature of the hot water to 80-90°C without tracking. Besides, a storage tank is connected to the



hot water supply with return headers. Finally, the solar thermal system was integrated with a biogas backup burner for uninterrupted operation of the system. The solar collector system show in Fig. 2.



Fig. 2: Solar thermal field

Biogas plant

Low cost and easy to maintain fixed dome biogas plants design developed at PAU Ludhiana was adopted for this project. A 50 m³/day biogas production



Fig. 3: Fixed dome type biogas plant under construction

Dr. V Siva Reddy working as a Principal Scientist & I/C Head Solar Energy Division at Sardar Patel Renewable Energy Research Institute (SPRERI), Gujarat.



Er. Sampath Kumar working as a Research Associate in Solar Energy Division at Sardar Patel Renewable Energy Research Institute, Gujarat.



Er. A Gokul Raj working as an Associate Scientist in Solar Energy Division at Sardar Patel Renewable Energy Research Institute, Gujarat.



Er. Tilak Chawada worked as a Senior Scientist in Solar Energy Division at Sardar Patel Renewable Energy Research Institute, Gujarat.



capacity plant is under construction (Fig. 3). One tonne of cattle dung will be feed into the plant every day. The produced digested slurry will be transported by a tank to the farm for crop production/ vermicompost etc.

Vapour Absorption Machine

A lithium bromide-water VAM of 5TR rating for the generator temperature of 80-90°C and evaporator temperature of 9-6°C has been installed (Fig 4). The prototype of low capacity VAM was developed by M/s Voltas Ltd for the first time for this project.



Fig. 4: Vapour Absorption Machine

Solar PV power plant

For meeting auxiliary power requirement of the system, a 10 kW power plant is under installation. It consists of 40 PV panels each of 250 W



Fig. 5: Solar PV power plant

capacity (Fig 5). The PV output is connected to a 15 kVA inverter for operating various pumps & air blowers.

Cold chambers

Three prefabricated cold rooms each of 3 Tons of loading capacity was designed, installed at the ground floor (Fig 6). A 1.5 tonne capacity air handling unit has been installed inside cold room after considering various parameters like the heat load in the cold room, heat loss through the walls, air change load etc.



Fig. 6: Cold chambers

Operation and controls

Control panel was programmed and installed for controlling operation of the pumps, recording the temperatures and energy consumption data. Water is pumped from the hot water storage tank to the collector header, where it is heated to 90°C and returned to the same tank. Hot water at a temperature of 85°C pumped from the storage tank to VAM generator and 80°C is returned to the same tank. Between the hot water and VAM, a



Fig. 7: Top view of system integration

Time 24/12/14	Hot water			Chilled water			Cooling water			COP
	In Temp. (°C)	Out Temp. (°C)	Flow rate (LPH)	In Temp. (°C)	Out Temp. (°C)	Flow rate (LPH)	In Temp. (°C)	Out Temp. (°C)	Flow rate (LPH)	
12:00	78.9	66.1	6062	17.7	15.9	5690	25.30	30.20	8026	0.13
12:15	78.8	66.7	6013	16.9	14.6	5637	25.80	30.50	8023	0.18
12:30	78.9	67.4	6154	16.4	13.9	5634	26.40	30.20	7960	0.20
12:45	79.2	69.0	6157	15.5	12.8	5668	26.10	30.20	7994	0.24
13:00	79.7	70.0	6108	14.7	11.8	5608	26.20	29.90	8034	0.27
13:30	80.3	73.1	6113	13.6	10.3	5668	26.10	29.70	8029	0.42
13:45	81.1	74.2	6105	12.4	9.1	5689	25.50	29.40	7846	0.45
14:00	81.6	74.6	6061	11.4	8.6	5668	25.50	29.00	7738	0.37
14:15	81.9	75.2	6018	11.3	7.8	5639	25.00	29.00	7960	0.49
14:30	82.2	75.5	5892	10.6	7.1	5610	25.50	29.00	7963	0.50
14:45	82.4	75.8	5844	10.1	6.9	5665	25.10	29.00	7843	0.47
15:00	82.5	70.0	5894	10.4	7.0	5612	25.30	28.40	7852	0.26

Table 1: Performance results of the vapour absorption machine

biogas backup burner has been installed as a backup source for water heating when its temperature below 85°C. The chilled water stored in two tanks is used to take care of the fresh loads. The water from first chilled water tank is pumped to the VAM evaporator where it is cooled to 6°C and pumped to the second chilled water storage tank. The chilled water at 6°C from second chilled water tank is pumped to the air handling units for creating cooling effect in cold chambers. The heat gained by the returned water collects in the first chilled water storage tank.

Performance result of the system

Performance evaluation of the solar thermal energy based refrigeration system has been initiated. Initial data collected for the VAM and solar thermal field for atypical winter day are summarised in Table 1 & 2. The VAM operated for 3 hours time to cool 3000 liters of the water from ambient of 18°C to 7°C. The cold room temperature dropped from 23°C to 9°C under no load condition within one hour. Further performance trails are in progress.

Time 24/12/14	In Temp. (°C)	Out Temp. (°C)	Flow rate (LPH)	Solar Radiation (W/m ²)	Efficiency
10:15	57.1	64.1	5678	601	0.52
10:45	71.6	77.1	5660	686	0.36
11:00	73.2	78.7	5644	691	0.35
11:15	85.1	90.9	5105	746	0.31
11:30	88.1	95.1	4834	769	0.35
11:45	84.6	92.5	5094	741	0.43
12:00	84.2	92.5	5103	754	0.44
12:15	84.4	92.2	5132	746	0.42
12:30	84.5	92.2	5112	751	0.41
12:45	84.6	92.5	5105	725	0.44
13:00	85.4	93.3	5006	708	0.44
13:30	86.5	95.1	4956	654	0.51
13:45	87.3	95.5	4871	633	0.50
14:00	87.7	95.4	4823	610	0.48
14:15	88.1	96.1	4794	564	0.54

Table 2: Performance results of the solar thermal system

Further plan of work

- Commissioning of the 50 m³/h capacity biogas plant for thermal energy supply during non solar hours.
- Integration of the biogas supply line to existing gas burner.
- Performance evaluation of integrated transient storage facility during summer, rainy and winter seasons under full load conditions including the product quality.
- Open the facility to the possessive formers of the neighbourhood for use and feedback.
- After successfully execution few demo systems will setting up is selected production catchments for techno-economic evaluation. ■



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HVAC System - a project



Shrujan is a not-for-profit making Trust. Shrujan began modestly as a small project sponsored by members of the extended Shroff family. Any income that is generated is returned to the project. Chandaben Shroff developed a unique, sustainable means of income generation for village women. She got the local women to produce saris with exclusive embroideries. The profits were re-invested into building the organization. Currently Shrujan works with 16 different styles of embroidery, done by 3,500 women across 100 villages. The following article describes a project by the Shrujan Trust at Paddhar village, Kutch, Gujarat, for upliftment and empowerment of the local craftsmen. The project includes buildings for training, manufacturing, storage and exhibition of handicraft products. The products are to be maintained at specific temperature and humidity.

We have suggested innovative systems for reduction in load coupled with high efficiency refrigeration systems. The entire exercise is aimed at

providing thermal comfort to the occupants using minimum amounts of energy or water mostly by natural means or if absolutely necessary by using air conditioners & dehumidifiers with high energy efficiency.

General Description

Our approach would be to suggest load reduction methods coupled with high efficiency refrigeration system. The result would be a cool, comfortable and healthy environment at 30% to 50% less energy cost.

Major proposals are outlined as under:

- Summer cooling and winter heating will be provided by a thermal storage system comprising underground storage of water that would absorb the heat from the structures and used that stored energy to warm the occupied areas in the winter. No refrigeration or heating energy needed.
- A special system with redundancies will be designed that will maintain temperature and humidity

conditions stable in the secure storage/exhibition areas.

- Ventilation systems using wind towers to keep discomfort away in work areas. This in addition to structure cooling/heating.
- The auditorium will have a two tier cooling system. A dehumidifier will carry the latent and fresh air load, while cooling will be done by cool (not cold) air supplied under the seats.

The above services shall cover the following items as and where required:

Load Reduction

- Natural Cooling
- Wind Tower

Improving Indoor Air Quality

- Treated Fresh Air System

Energy Saving Through Increased EER

- 2-Tier Cooling

List of System Groups

Structure Cooling System –

Direct structure cooling system is used on the area which directly expose to sun like roof and open area, outside



Julius Teles, is Design Manager in Panasia Engineers Pvt. Ltd., Mumbai. An HVAC & Structure Cooling Expert, he has a professional experience of 18 years. He has many projects to his credit.



Particulars	Installed System
Temporary Exhibition Gallery	a. Fresh Air Dehumidifier (3 TR)
Conference	a. 1.5 TR High-Wall AC - 4 Nos
	b. Fresh air from wind tower (200 CFM)
Auditorium	a. Comby Unit (7 TR) (5000 CFM)
	b. Provision for fresh air dehumidifier in future (5 TR)
	c. Fresh air from wind tower 2000 CFM
Total Admin. Area	a. Provision for fresh air dehumidifier in future (5 TR)
	b. 1.5 TR Hi-wall units (2 Nos)
Library / Curatorial	a. Fresh Air Dehumidifier. (3 TR)
DCOW / store arrival	a. Fresh Air Dehumidifier. (3 TR)
Gallery	a. Fresh air dehumidifier. (5 TR)- 2 Nos
Gallery	a. Fresh Air Dehumidifier. (5 TR)- 2 Nos
Main Storage	a. Fresh Air Dehumidifier. (5 TR)- 1No
Terrace	a. Direct structure cooling

Piping for Structure Cooling



Wind Tower



gallery area etc. This system maintains the MRT of the room is between 30-35°C. This temperature is equivalent to the skin temperature. Hence this condition can be assumed to be 'neutral'. This means that neither there will be any radiant heat transferred from the structure to the human body and neither there will be any heat loss from the human body to the cooled structure. Hence the simulation predicts that the system can successfully eliminate any radiant heat gain from the structure.

Dehumidified Fresh Air System

This system will provide fresh dehumidified outside air without mixing with return air to the breathing

zone of the occupancies. Since we are treating outside air to the low dew point and supplying near breathing zone the quantity of air required will be less as compared to conventional system. This system will reduce the CO₂ level inside the room ad compared to conventional Air conditioning system.

Ventilation with Wind Tower

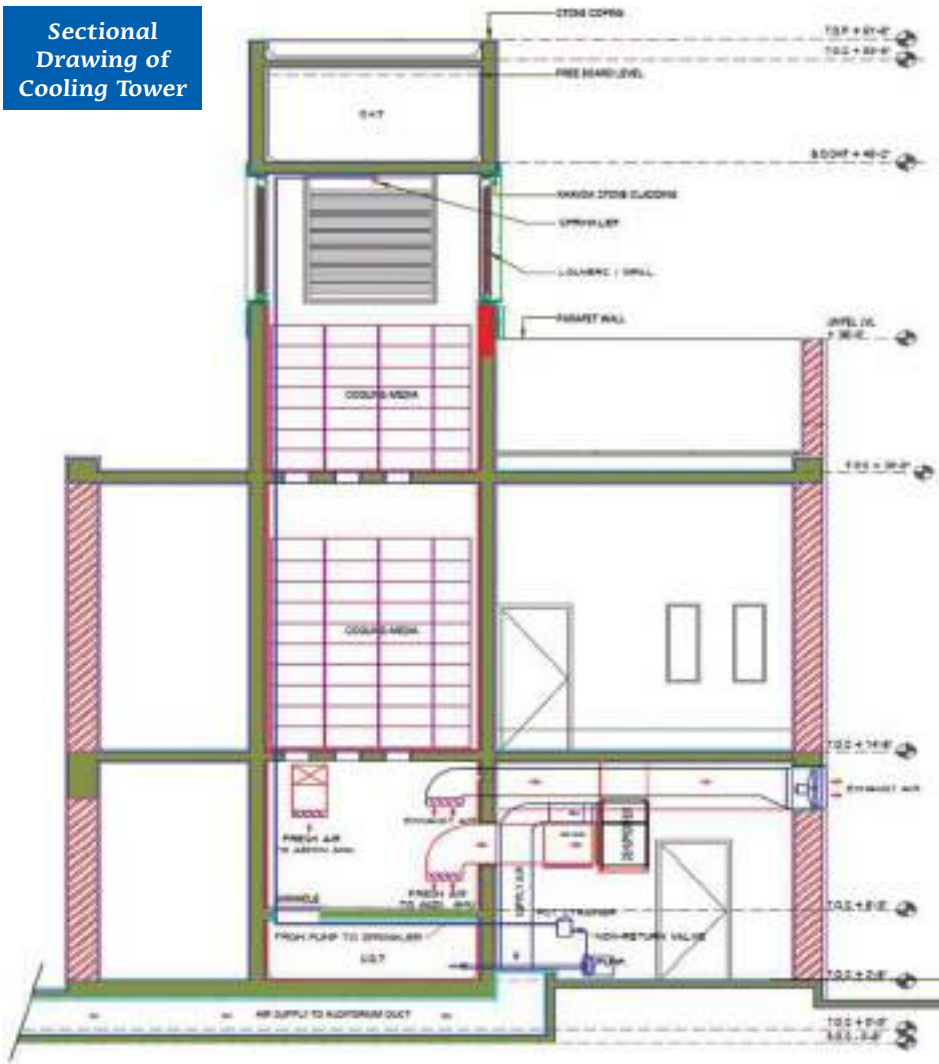
For Ventilation purpose or for maximum fresh air requirement we use Wind Tower. Here we proposed Wind Tower for area where fresh air requirement is high. Example - Auditorium, conference room and admin area. Wind towers use gravity to move cool air without any fans. They

do this by having a wet medium in the top of the tower. Since cool air is heavier than warm air, it will fall, creating its own airflow. Wind is not required, but will improve the airflow in a wind tower.

Air Conditioning Systems

- **Comby Air Conditioning:** Our Comby low humidity air conditioner is a stand-alone machine that maintains desired conditions, without any external heaters or dehumidifiers. It incorporates highly energy efficient patented dual pressure evaporator and saves over 60% energy in comparison with the conventional units with electric heaters or dehumidifiers.

Sectional Drawing of Cooling Tower



- Sensible cooling:** Since we are treating the each load separately we use the Hi-wall units or conventional DX units working at high temperature. That will provide efficient cooling as well as it will reduce the power consumptions. Systems were proposed as per particular rooms requirement of thermal comfort and to increase the productivity.

Chart in the previous page is showing installed system for particulars as required.

Conclusion

It is the first large Scale structure cooling System & natural cooling system which also is incorporating high efficiency Refrigeration for dehumidification and fresh air cooling. When fully operational it could become a watershed for green technology application.

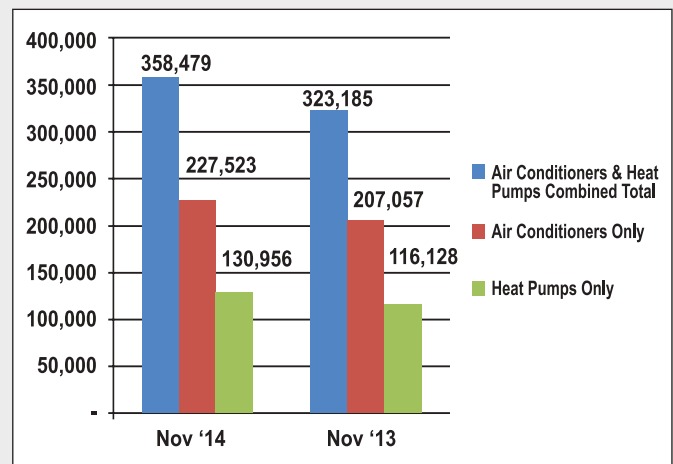
Author wishes to express their sincere thanks to the trustees, the architects, Uday Andhrae and dedicated team of the Project. ■

AHRI: November 2014 U.S. Heating and Cooling Equipment Shipment Data

Central Air Conditioners and Air-Source Heat Pumps

U.S. shipments of central air conditioners and air-source heat pumps totaled 358,479 units in November 2014, up 10.9% from 323,185 units shipped in November 2013. U.S. shipments of air conditioners increased 9.9%, to 227,523 units, up from 207,057 units shipped in November 2013. U.S. shipments of air-source heat pumps increased 12.8%, to 130,956 units, than shipped in November 2013.

Year-to-date combined shipments of central air conditioners and air-source heat pumps increased 9.0%, to 6,391,815 units, up from 5,863,559 units shipped in November 2013. Year-to-date shipments of central air conditioners increased 5.1%, to 4,221,291 units, up from 4,014,584 units shipped in 2013. The year-to-date total for heat pump shipments increased 17.4%, to 2,170,524 units, up from 1,848,975 units shipped during the same period in 2013. ■



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Commissioning of HVAC Systems

Practical Aspects



As the green building movement in India gathers steam, there will be a greater awareness amongst all stakeholders in the building for the need for equipment's and systems to operate as per the design originally planned. Sustainable operations are a goal of all green building rating systems and one important requirement of such systems is the need for "commissioning" the utilities in particular and the building in general. This essentially means a process where the equipment's and systems are installed and tested with an aim to see that they perform as per the OEM's specifications and give the output that was planned.

Building commissioning is gaining popularity in India, not only because it is a mandatory requirement of the Green rating systems, but also because of an increased awareness of the benefits of commissioning that the developer or owners get when they go through this rigorous process for their high cost equipment and systems. HVAC systems contribute to over 40% of the utilities costs for a building and are also very complex as they interlink with various sub systems within the building such as the BMS, electrical systems etc. HVAC system is also single largest consumer of energy in the building, contributing to over 45% of the cost and hence, there is a financial need to ensure that the HVAC system runs as per the design intent which is a key goal of commissioning.

What is Commissioning!

Commissioning is essentially a process to ensure that the final product is what was originally thought of or designed. ASHRAE standard 202 – 2013 defines commissioning as "the process of verifying and documenting that all systems and equipment's are planned, designed, installed, tested, operated and Maintained as per the owners project requirements". Thus, not only is it enough to see that the equipment's installed meeting the OEM's specifications; they should also meet the original design intent. The commissioning process goes a step further in looking into aspects of O&M so that the systems continue to operate as per the original design requirements.

Commissioning typically is of the whole building, and can be for new as well as existing buildings. The major component of the commissioning process is the HVAC system as this system factors for a major part of the installed expense as well as life cycle expenses. Green building ratings systems also require that the building and systems are commissioned & credits are given for this activity. LEED rating system has two types of

commissioning – Fundamental commissioning is the basic requirement and is usually undertaken by contractors team, whereas enhanced commissioning is more extensive and is carried out by an external independent agency on behalf of the owner.

Commissioning Process

While the approach to commissioning can vary as per the project and commitment of the developer//owner of the HVAC systems, a structured approach is described in ASHRAE standard 202- 2013, more specifically guideline 1.1 HVAC system commission 2007. Typically, the commissioning process covers both the design stage and the construction stage as well as post startup phase.

Fig. 1 lists the typical stages of HVAC commissioning in a building environment.



Fig. 1: HVAC Commissioning Process Overview

Pre Design/Design Stage – This is the initiation of the commissioning (Cx) process, where the developer appoints the agency responsible for commissioning. This agency then sits on design and specification development meetings and understands the Owners Performance Requirements (OPR). This stage is crucial for a successful commissioning as it lays down what is the end result that the owner wants and allows the commissioning agent to share inputs on design based on their experience on other projects. The commissioning plan is also developed at this point. Once the plan is drawn up, the Cx team reviews



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design and also develops testing protocols and training requirements.

Construction Stage – Once OPR is defined & construction begins, commissioning process focuses on verification of various construction activities such as installation, system balancing,

testing of stage wise assemblies etc. The Cx team also focuses on preparation for handing over to operations and maintenance teams as well as review the training imparted to the operations team. A system manual, listing various aspects of HVAC systems is also prepared at this stage.

Operations Phase – This is the most crucial phase of the transition process as it involves the actual testing of the equipment's and a final handover to the owners operating agency. During this phase, the HVAC system is tested in parts and then as a whole to identify areas where the operations differ from the original design. The involvement of the operations staff, contractors team, project management teams as well as external agencies where applicable makes this a complex task and most commissioning initiatives fail at this stage. There is the added pressure of the making the building operational for its intended use.

Key Activities in HVAC commissioning

The HVAC system is the most complex one in a building environment as it includes a large number of sub systems and therefore, there are many interlinked activities that need to be coordinated. Some of the main activities that are undertaken during HVAC commissioning are shown in Fig. 2.

Test during Construction	Functional Tests	Post Go Live
<ul style="list-style-type: none"> • Ductwork Air leakage test • Pressure testing of piped systems • Pre commissioning tests-Air, water systems • Air Balancing 	<ul style="list-style-type: none"> • Water Distribution systems • Air Distribution system • Gas side systems 	<ul style="list-style-type: none"> • Electrical system test • BMS integration • Final performance testing

Fig. 2: HVAC Commissioning Major Activities

An important aspect is the need for calibration of test equipment during the commissioning phase. The test protocols are also defined in various standards as well as listed down by the OEM/contractors. The final performance testing is usually difficult to do at the time the building becomes operational in

case of commercial buildings as the occupancy is only partial. This activity thus gets either left out totally or is undertaken with partial load and closed out which ultimately negates the benefits the whole commissioning process of As the load in a building that is partially occupied is not at the design point,

Benefits of Commissioning

The earlier in the building development stage the commissioning process begins, the more is the cost for the commissioning. However, this also translates to a higher savings that the owner can expect from a system closer to design once it gets operational and hence the benefits outweigh the cost.

- Lower operating costs: Studies in US have shown that the average return on investment (RoI) for HVAC commissioning in existing buildings is approx. 1.5 – 1.7 years. The savings also were seen to run over for 3 – 5 years post commissioning, thus enhancing the overall savings achieved.
- For new buildings, the O&M teams get a system that has fewer defects at the time of handover and a higher degree of reliability.
- The number of system change requirements during the construction phase reduce due to the continuous monitoring of the process by the Cx agency.
- Faster transition from the construction phase to building operations phase as any major project related issue is usually sorted out by that time.
- Availability of a full set of system documents that can be used during the life of the equipment.
- Due to focus on training during commissioning, staff is trained which reduces operator errors related downtime.

Conclusion

A well-executed building project should ideally result in systems and equipment's working as close to the design as possible. However, due to the complexities of the building process, the end result is usually not what is desired and is often seen that a lot of rework needs to be done or the planned operational efficiencies are not achieved, resulting in higher operating costs. Commissioning is a method to ensure that the owners get what they are paying for, and the cost of operations remains as per estimated budgets. This activity is gaining popularity in India, and a number of third party commissioning agents are now available to assist developers in this task. While commissioning for new construction is now gaining popularity partly due to the requirements in Green rating systems, there is a need to look at increasing its use in existing buildings which were originally not commissioned. This will save the owners, operating costs and also result in a more sustainable approach to HVAC operations. ■



John Ritmann, Director Ammonia System Engineering, BITZER and **Rob De Bruyn**, Managing Director, BITZER Refrigeration Asia Pte Limited, during an interaction on sidelines of ARCON 2015 remarked to Gopal K Anand from **Cooling India** that Bitzer has intelligent design, intelligent controller and intelligent technology.



Peter Schaufler, BITZER has initiated a large training center in Germany

Could you reveal the purpose that brought John Ritmann for participating in ARCON 2015 event?

Rob: Let me give some understanding about John Ritmann, Director Ammonia System Engineering, BITZER. John is most qualified and senior executive of Ammonia system Engineering in ammonia business. He is driving global applications for system engineering. We believe that it is good opportunity for John to come and understand market of course. India is changing geographically. Bitzer is participating and it is a good and nice opportunity for John to come to India and understand what is happening in the market so that we can all work towards same end results and to built stability and business in India, for growth in India and to participate in the growth of refrigeration sector. That is the purpose of John being here.

Could you brief about Bitzer's refrigeration business?

John: Bitzer has many years of presence in the market Refrigeration with all largest players in the market. We have opened a development office with 6 guys in Denmark where we are preparing Industrial products bringing Bitzer more dedicated into industrial refrigeration. Its huge potential for Bitzer and let us say the legislation in Europe is also pushing us to take more active part in this area. We are emphasizing not only developing compressor but also larger compressor Pack's into specific markets. All our compressor packages are selling around the world. We have many originals. Our first Industrial Compressor Pack in US was displayed at IAR and right after we

sold it as first field test unit to a warehouse near Atlanta in July last year. No problems so far and other Customers are willing to buy. We initiated in Brazil as well. We also have first features available in Brazil from our factory in Sao Paulo.

Where are your manufacturing facilities located?

John: We are using our own manufacturing facilities like in Atlanta US and Sao Paulo Brazil. As mentioned we have first unit built and presented in south Brazil at Merco Agro in Chapeco. We are looking for opportunities and activities here as well and to support our local effort for the existing ammonia market being more focused on compressor.

What is the potential and opportunity to visit this event?

John: To get to know people from here and discover the demand in India market which is very interesting. I do not know much of India but its good to get more details about the local products and business approach.

For how long you have been associated with ammonia refrigeration?

John: Oh! Whole of my working life! Since I came out of university I got associated directly to company Sabroe, dealing mainly with ammonia, ammonia, ammonia and CO₂. I was mainly working inside global product management, meaning I was involved in nearly all developments from the perspective of continuous optimizing ammonia and later also subcritical CO₂ systems.

All of a sudden necessity for ammonia has arisen in view of the HFC phase out and other synthetic refrigerants and which one is a primary refrigerant?

John: I come from the Industrial side, where ammonia is the obvious primary refrigerant over time and not only in Europe and as you can see with increasing pressure on the use of HCFC, HFC etc. This has generated a need for new developments inside all applications. Airconditioning using Ammonia are at the moment one of the most growing applications in Europe. Normally with a secondary refrigerant it is often being used in larger scale equipment like in centralized systems. There is still a need for entering into and looking for development of products and ways to cover the many applications where ammonia is not the only obvious choice. We also cannot allow premium price just because we use ammonia but again a lot of development is going on. Industrial refrigeration will keep developing industrial equipment. I don't think the industrial players will be able to develop smaller air conditioning equipment, since it will then become too expensive. Smaller contractors will fall into line first. See how the development in commercial refrigeration using transcritical CO₂ took place in Europe, not by the larger players but driven by smaller companies introducing new transcritical CO₂ systems. Many smaller and new companies are coming up and can see these opportunities. They are often being supported with Bitzer know-how and compressors. Whether you chose Ammonia, CO₂ or Hydrocarbon for a new application, you need to have deep insight in chosen technology and safety but also the demands & needs from the corresponding industry.

Rob: I think a lot of smaller players are focused, adapt easily. And systems are becoming smaller and smaller for configuration to answer and I think the existing equipment needs to be adapted to requirement. We have a lot of customers, actually adapting very nicely from retrofit point. What we have got we are moving with existing understanding to new concept, new control, systems and processes at every phase of development. We see complete change in adaptation of these equipment. It is very interesting. In my opinion, India guys are very innovative in this respect to change to things and look at cost structure which is highly competitive. This is coming from various regions in India.

What is the scope of refrigeration in India & globally from the point of view of climate change happening globally?

John: You are fortunate in India compared to many other countries. You use in India a lot of ammonia already. You do not need very big changes in nearly all industries. You already are used to ammonia and therefore have better capability to also develop from that point of view. Many countries have still not got out of R22 at all and some countries are still using so much R22 that you can hardly imagine. So, it's a much bigger task for them to adopt to future demand. I think companies in India are acting with a lot of smaller companies, using right methods and have sufficient know-how to innovate and adopt to future demands. These guys are the ones who can help to support in driving necessary changes.

What is the market potential for ammonia technology?

John: It is huge. Our focus is on a lot of application. We need to move focus from traditional refrigerant HFC to use ammonia for many applications. We have to see and think out of the box. NH₃ is not for kids. As an example, we show a containerized test unit in Germany. We have a 1.3 MW capacity unit with 78 kilos of ammonia, and that is amazing! Considering ammonia less dangerous with less charge, it can be a solution driver in populated areas. You have opportunity to make unit compact, put enclosure and put it on the roof etc. This is an opportunity for larger installations of NH₃ in middle of cities. We need to see future in another way. We have to think out of the box because we cannot just prepare future systems with existing technologies.

Do you think ammonia is hazardous material? What are the safety measures you are adopting?

John: It is. To reduce the refrigerant charge is one way, but still safety must always have top priority together with proper maintenance. Redundancy is highly requested to ensure continuous operation despite failures but also plays an important safety role. To meet contingency we are building controllers into system if failure occurs. Redundancy ensures the possibility to isolate and repair unsafe components which retains the quality and safety and responsibility to user. Do you have selective maintenance, suppose NH₃ pipe is there or leak has appeared at some point whether that can be bypassed or if you can locate that particular point. Parallel operation covers that from the compressor side but things are considered different in Europe. We got stringent requirements for all processes of building and operating NH₃ plants. For instance, it's required 10% X-ray of all weldings, full trace ability of all materials and welders incl. Certificates. This ensures a very high level of quality and safety of all the individual components. There are also requirements for service personnel describing necessary skills

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before being allowed to enter a refrigeration plant room and operating and or doing maintenance of the plant.

So you must have installed automation systems also for that?

John: Of course also in compressor unit but mainly this is an issue for larger industrial system. We provide a safety through our controller system but its actually mainly controlling the system and not recognized as part of the basic safety. The safety is still based on HP cut out for each compressor, unlike in US where they are allowing the control system taking care of safety. This is it is not allowed in Europe.

Rob: Let me suggest, it also very interesting to understand the leak. Assumption here is - in case of leak, you need something to bypass. I think the European ideology is the assumption that it would not leak. Whereas we are still building theoretical design in engineering to ascertain as to what happens when it leaks. For bypass, it makes the system more complex even more difficult. From engineering point its important to distinguish these imbalance and Its good to understand it that its a measure to prevent downtime and failure.

John: Correct we expect the system to be safe and carry out scheduled maintenance to keep it safe NH₃ is self alarming. You can detect a very low concentration in the room, then you know something is wrong and in case leakage, bring only skilled people to repair. Basic to safety is also that every time you see a potential risk of leakage then repair it properly. What you often can do is to isolate the system with the failure. To keep the unit operating we recommend redundancy, for instance, by using double sensor. In case one sensor fails another can take over. If the CPU is failing, the controller CPU back-up takes over. It is more like a philosophy, first of all about keep high.. high.. high safety standards but also pay respect to that unit must continuous operate to serve the process. It is important to train and create awareness of safety for the people who are working with it.

For that you have training centre also!

John: First of all if you are looking into the recent history. Bitzer was one of the major contributors in developing the CO₂ business during the last 5-10 years. Bitzer took full responsibility in training people and are still having visits nearly every week. People were trained hands-on in sub critical and trans critical systems at the BITZER screw compressor factory. The owner, Peter Schaufler, CEO of BITZER has initiated a large training center in Germany, so that we are ready to make training for NH₃, Hydrocarbon, CO₂ etc. BITZER want to continue being the leader in training of refrigeration people and this is very important since a large industry is not used to handle many of the new future refrigerants.

Rob: We are also doing the same for Green Points Service Center, sending people, generally engineering stuff, from here to Germany constantly, for training. What happens it is not easy to bring 100 guys from industry to Germany but training in different sessions, we can do that. We can send Bitzer people -Indian guys, and of course, we are training some bigger customer in Germany. So this is ongoing activity. Training is very big part of Bitzer culture. Always and of course now Mr. Schaufler is doing major training center, its very important part. It is in Germany.

Which place the training center is?

John: The New Bitzer International Training Centre is located in Germany. It is situated in Rottenburg-Ergenzingen where it will become the new entrance for both the training centre and the Bitzer screw compressor facility. It's indeed very impressive and it shows clearly how progressive we are when driving up the new road named after the owner: Peter Schaufler Street.

Could you detail about compressor range using ammonia technology?

John: Yes. The widely used range comprises screw compressors up to 500—600 cubic meter. We are serving the industrial market with parallel racks and last year we launched a new 1000 cubic meter screw compressor at Chillventa in Germany. It's a new designed compressor range dedicated to the industrial refrigeration. This compressor is 100% designed for the Ammonia business and our focus will be continued serving this market by following up with larger compressors in future.

How much importance do you attach for this type of conventions taking place second time?

Rob: Very important. It is the Ideal forum for all customer parties, and customers. It is a good place to exchange ideas, new concept, new philosophies. I think, probably one of the most important forum we can participate since everyone is coming here with open mind, talk to each other, seeing new things, ideas and how do we adapt, how do we go with industry, how do we ultimately convince government that we are responsible industry. Its very important any for any industry participant.

What are your views about Make in India initiative that means manufacturing here?

Rob: Owner, P. Schaufler initiated a large training center is the one who started this company with open mind. Bitzer is going to be global company moving in pace with market need. We believe India is developing at this moment though business manufacturing volume may not be high. India, at some point in far future needs to be manufacturing. We are focussed on that. If we look at figures for most of years we have the selling capacity for more than 15 years and it is a good market for Bitzer. We have lot of support from industry and are active with spare parts, service centers. Bitzer has lot of support from industry. It is very important we must provide answers for customers to connect. We are excellent manufacturer from Europe. We believe Indian culture is known for quality and new compressor may be different from Europe. We have major support from all industry participants. We are proud that we have been able to achieve that in India.

How much market share do you have in India?

Rob: I would like to say 100%. We have got high market share in competitive product we serve. Talking share we have to also understand different markets. It is different market. We talk about configuration very high, if we talk about Screw compressors, extremely high; if talk about pressure vessels extremely high. Then technology driving into market place as energy efficiency becomes more imp. New technology

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THE HEART OF FRESHNESS

business is driving as energy efficiency is a major issue and has got to be high on priority. Many compressors are coming with integral invertors' technology.

Compressor being the very vital component of any refrigeration system or airconditioning so what are technological advances Bitzer has achieved?

John: In BITZER we use to say that the compressor is the heart of refrigeration and adding to earlier discussion, Bitzer wants to bring more and more intelligence to compressor especially in my area of NH₃, were people need to be more skilled to handle new technologies like inverters etc. With efficient components, customer is also getting successful. We are developing compressors for larger industrial systems were efficiency is taken very serious, due to the many operating hours of larger drive lines. Here we're focusing on always being the best in class.

Rob: We are heading into area where we are controlling compressor itself. Devices are good. Bitzer is now developing its second protocol which says power demand is too high, so we are reducing demand on compressor. The option is to slow it down so that demand is not high. In case temperature is up so, turns it off, but it does not keep cooling off, we can still control heart of configuration system from the core of control system. Then bring about technicians. We are in safety zone in compressors. We are more going into the future.

John: With wider perspective, if we are looking into future demand for power grid system, wind mills, Solar panels, we are not able to turn it on and off on demand. The wind blows when it blows. The refrigeration system must be able to respond to the grid request to for instance, lower the demand when you do not have so much power available. With this moving capacity demand system and response from the grid we can lower demand on power, but still we want to operate and adopt to what is power available, what is price of power. That we will see in future.

What is the response of Bitzer compressors in market as well as feedback?

Rob: Bitzer has intelligent design, intelligent controller and intelligent technology. We have wider market share and growing consistently. We have 4 compressor ranges. We can provide solution. For any refrigeration need we have solution. We are the widely operated factory in the world. On this basis I say that Bitzer is very well recognised and has got high branding. And the proof of result is technological advancement.

What are your views about being global with respect to competitors?

John: I agree Bitzer is the respected brand; I am a focussed guy on NH₃ bit is respected brand. We have capability to become largest. Bitzer is making more profiles and we have huge knowledge as to how to make it more efficient

and also how to operate them. All this Knowledge coming from millions of compressor and we are using it for development purposes. I foresee key of success is customer in the market, but they are happy with what we have been providing.

What are your expansion plans or do you intend any innovative technology with respect to ammonia refrigeration?

John: From refrigeration point we are moving slowly. We started off with US and then started off in Brazil. We are looking for opportunities, we do not have full plan as of now but we are looking into opportunity. We are not new and we have to look into capabilities.

Rob: Bitzer is a technological driver and descends from conservative family European company. We are careful in way and ensure that market no mistakes and marketing is correct, backing support is correct. For us It is not just selling compressor; sale would come we believe, if we get product right, market right and it seems good to business.

You have Green Point Service Centers? Fourth one is coming in Kolkata. Which centre elicits most response?

Rob: In India you can never have anything for granted. Kolkata has least population but demand for training and education, interestingly, is high. They are asking to share information about training, knowledge, product & equipment. Our primary objective is ensuring customer happiness with our product. Since compressor sale is high on east coast, it is interesting market. At the moment we are training boys' step-by-step. Green point is a backing support to customer. Kolkata is successful because of interest evinced. Its going very well and that gives confidence to customer.

What are other refrigerant that would take over ammonia in future ?

John: Hydrocarbon will be widely used. Companies are delivering equipment and there are more to come. There are more natural refrigerant to come. Entire industry is active to innovate and we have to take not only application by application but relocation. Climate change is global task. Its future opportunity for everyone to innovate and get attention in refrigeration to find out something new and its takes a great effort. So there is need for lot of innovation to find right solutions and new technologies. Like domestic freezers in Europe now nearly 100% are with hydrocarbon, the accidents are very close to none. Its also about learning about industries demand. We have old technology as inspiration and new technology is often found out of using basic component in a new way thus providing new opportunities.

What is your perception of Bitzer in next two years?

John: We move with strategy of Bitzer company about the product. We are all open with ears and eyes for opportunity with Bitzer. We are closely working with management in Germany about being here and my perception of India. We have good opportunity in India and we are all open for good business.

Thank you very much to both of you for an opportunity to have such a nice discussion. ■



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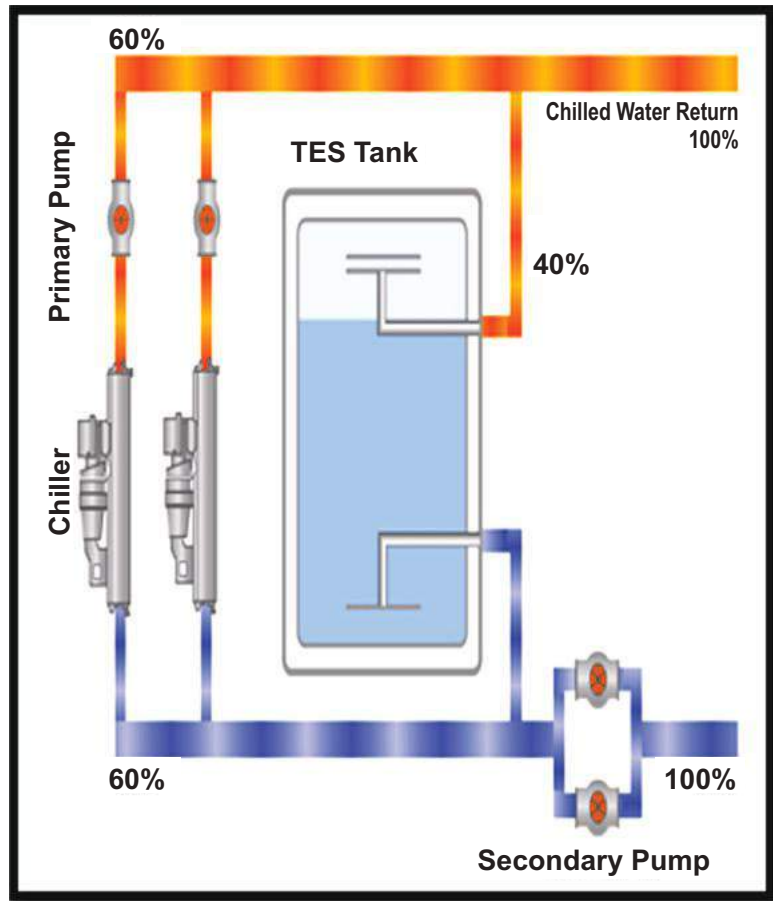
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Stratified Chilled Water Thermal Storage System



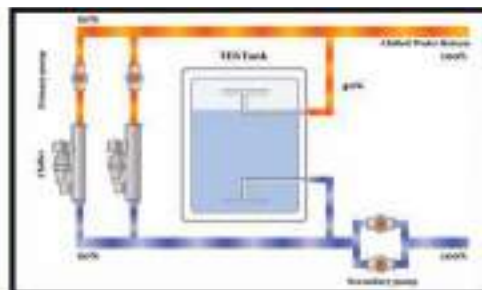
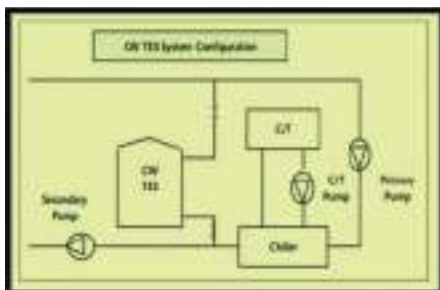
A Thermal Energy Storage tank integrates seamlessly into any chilled water cooling system. Because of the specially designed internal diffuser system, chilled water remains stratified within the tank, throughout the charging and discharging process. The key Technology of CHW Storage system is the diffuser design which ensures thermal stratification of chilled water and warm water by density difference. CHW TES has long history of installation and widely applied around the world including U.S.A., Japan, Korea and middle east Asia.

A thermal storage, when implemented into the cooling system of a building helps in reducing the peak demand and energy consumption, particularly when energy costs during peak periods are much higher than those in off-peak periods. Thermal Energy storage

systems can thus contribute significantly to the overall economy. The energy may be stored as ice or chilled water.

Thermal energy storage systems that separate warm and chilled water by means of gravitational stratification are being suggested in the cooling of buildings, because they can easily

be retrofitted into existing chilled-water systems. The performance of a stratified storage depends upon the ability to store warm and chilled water with little incursion of temperatures during its storage. The interfacial zone between the warm and chilled water in the storage tank, where there is a large temperature gradient, is called the



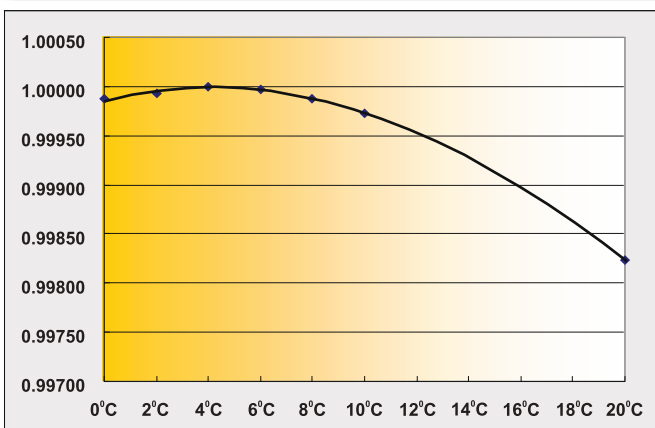
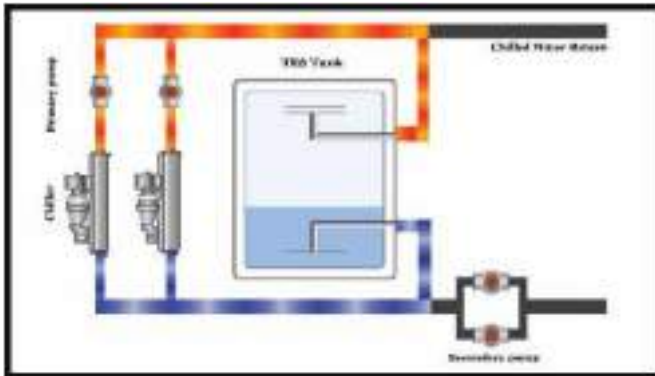
thermocline, and its thickness should be as small as possible. The increase in thermocline thickness with time is a measure of stratification decay in the chilled-water storage system and leads to the loss of cooling capacity. Stratification in a storage tank depends mainly on the temperature difference of the inlet and outlet. The available cooling capacity of the chilled water degrades owing to disturbance to the thermocline caused by:

- Heat gains from the ambient;
- Thermal diffusion from warm water to chilled water;
- Axial conduction in the tank wall in the vertical direction; and
- Mixing induced by charging and discharging of water.
- Stratified chilled-water storage systems have been studied.

Summary: How a TES Tank System Works!

Stratified chilled water storage tank utilizes natural stratification of the chilled water within the TES tank. Chilled water is a sensible storage medium (remains as a fluid). A naturally stratified TES tank is the main storage vessel used in a straight forward operating strategy utilized in a chilled water cooling system that utilizes only the sensible heat of water for cooling energy storage in a chilled water storage tank and discharges the stored coldness for air-conditioning during on peak time. This operation scheme reduces the total energy consumption and operation cost.

TES Charging (Without Load)

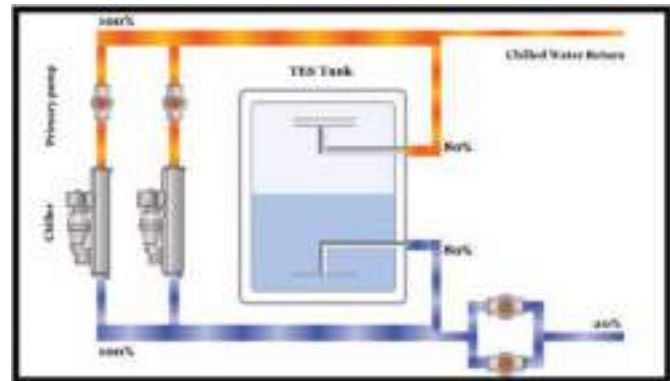


Dinesh Semwal, is Managing Director at Ensavior Technologies Pvt Ltd, a leading comprehensive engineering solutions provider company headquartered in New Delhi. Ensavior in association with FTENE, Korea provides total solution pertaining to thermal energy storage system to satisfy customers explicit and implicit needs.



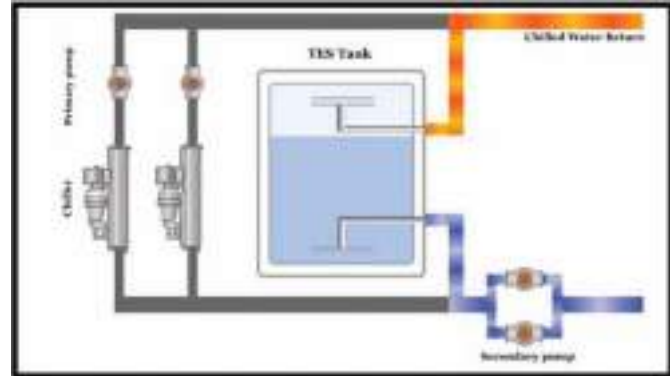
This system allows the TES tank to be “charged” and “discharged” of chilled water on a daily basis (see below schematic representation).

TES Charging (With Load)

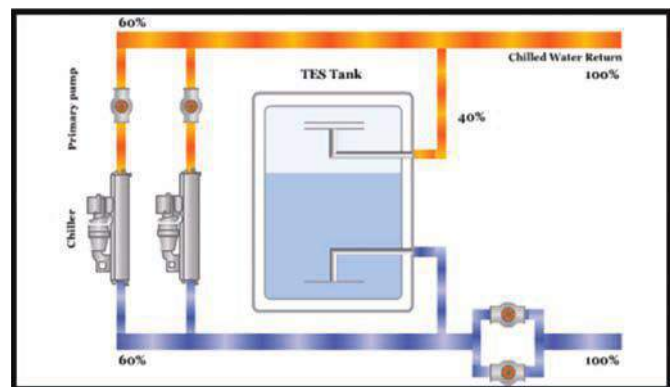


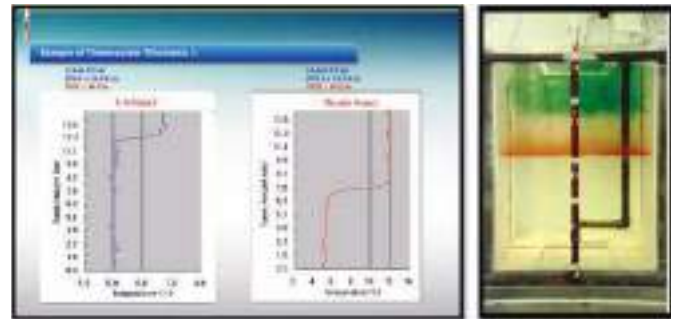
The stratification of CHW TES can be performed by utilization of the water density difference according to the water temperature. The density of water is heaviest at 4.0°C.

TES Discharging (Without Chiller)



TES Discharging (With Chiller)





water in the storage tank, where there is a large temperature gradient, is called the thermocline, and its thickness should be as small as possible. The increase in thermocline thickness with time is a measure of stratification decay in the chilled-water storage system and leads to the loss of cooling capacity.

Charge cycle

The chilled water at a desired temperature is charged through the bottom diffuser into the tank at the same rate as the warm water is displaced through the top of the storage tank. The thermocline forms at the bottom and slowly moves up to the top as charging is continued. During charging, the available cooling capacity of the charged water degrades due to mixing of the charge with the stored water. This is in addition to the thermal diffusion, axial wall conduction and heat gains from the ambient. Hydrodynamic disturbances caused by the high jet velocity of the inlet stream cause mixing of warm and chilled water. The thermal degradation due to mixing reduces with decreasing charge flow rate. Therefore, at very low charge flow rates, the thermal degradation is mainly a result of a combination of heat gain from ambient, thermal diffusion and axial wall conduction.

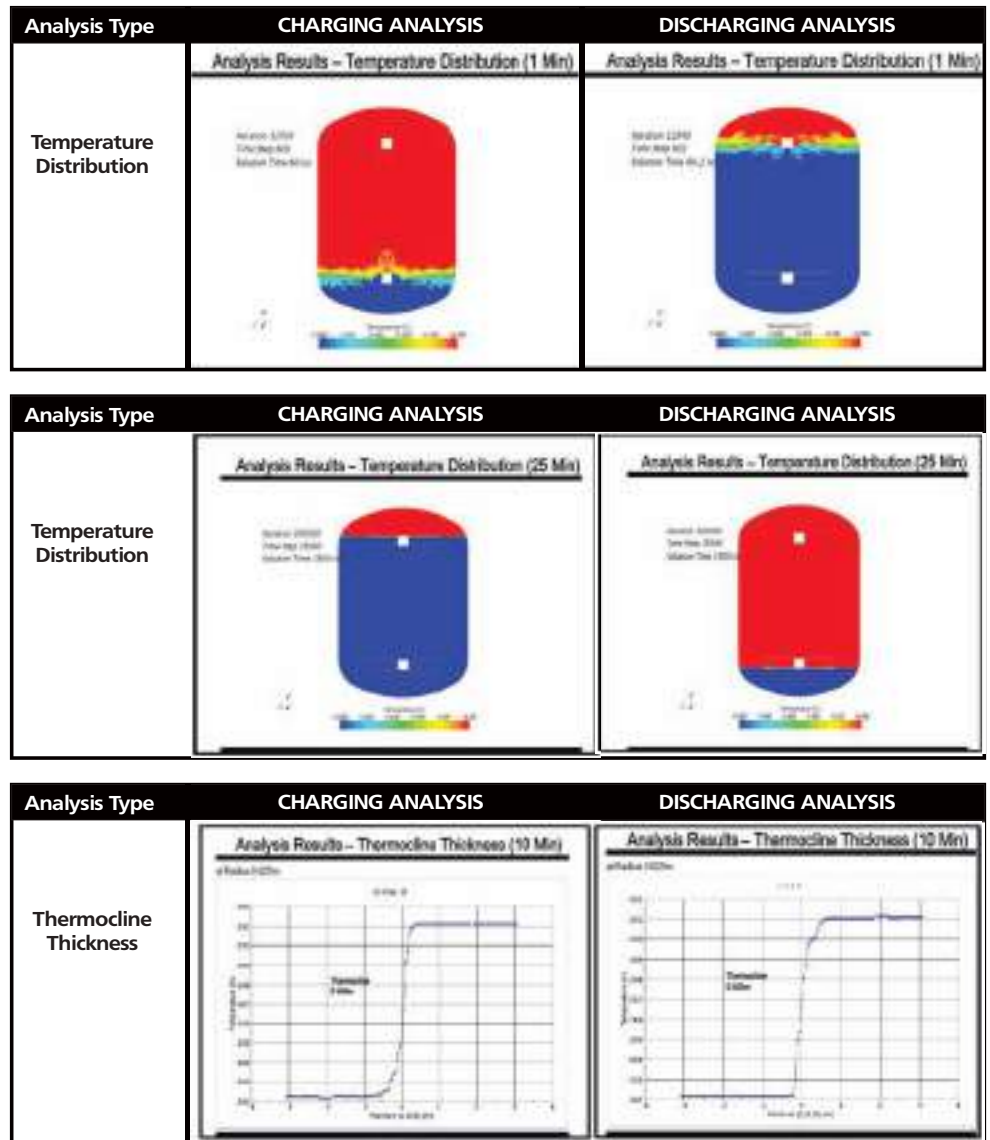
Discharge cycle

In a discharge cycle, the storage tank initially filled with chilled water is discharged through the bottom diffuser and returned to the tank through the diffuser at the top, after it is passed through the load. The thermocline forms at the top initially and slowly moves down to the bottom at the end of a discharge cycle.

Thermocline thickness

The interfacial zone between the warm and chilled

CFD Analysis for the Thermocline Behaviour in Thermal Storage Tank



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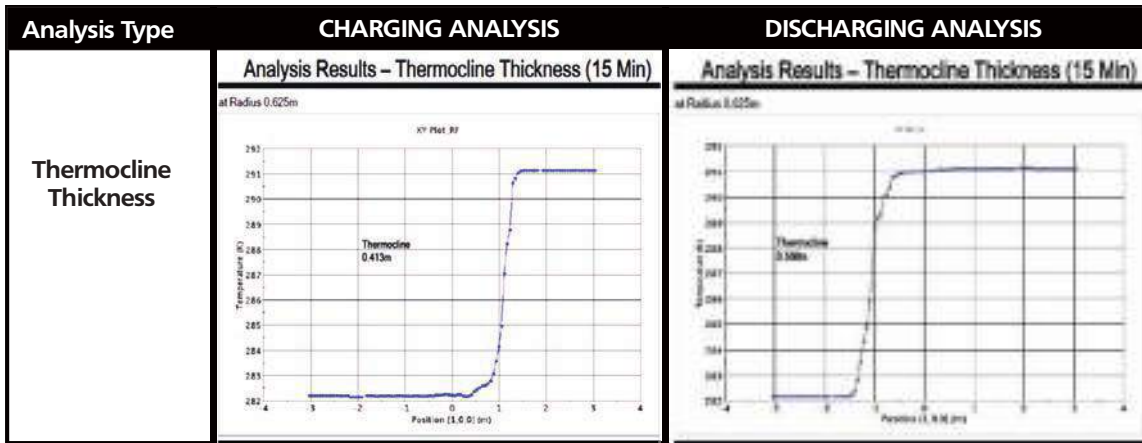
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Some Key Features of Chilled Water TES System

Naturally stratified chilled water thermal energy storage tanks are used as an integral part of a facility's air conditioning system, as well as for other

Design of Stratification Diffusers

Diffusers must be designed and constructed to produce and maintain stratification at the maximum expected flow rate through storage. Two main styles are in widespread use today: the octagonal pipe diffuser (see Figure 1) and the radial disk diffuser (Figure 2). Inlet and outlet streams must be kept at sufficiently low velocities, so buoyancy predominates over inertia to produce a density current across the bottom or top of the tank.

Radial disc type diffuser is simple in installation and due to the simple and strong structure, strong to the shock of the water hammering and surging. While the Octagonal pipe diffuser is weak to the shock of the water hammering and surging, has a higher pressure drop, difficult to install and takes long time to install.

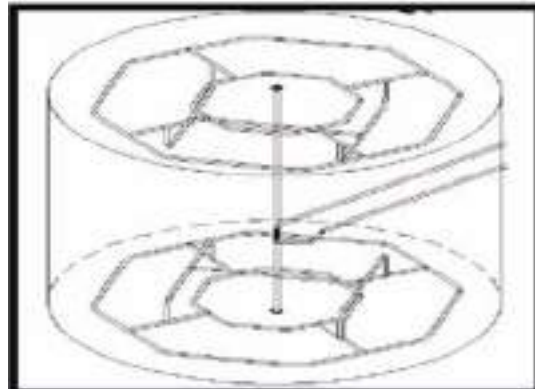
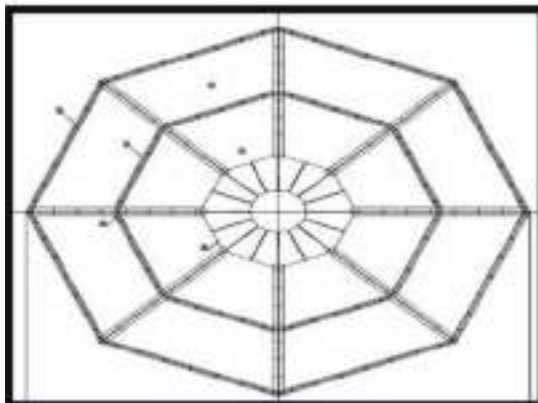
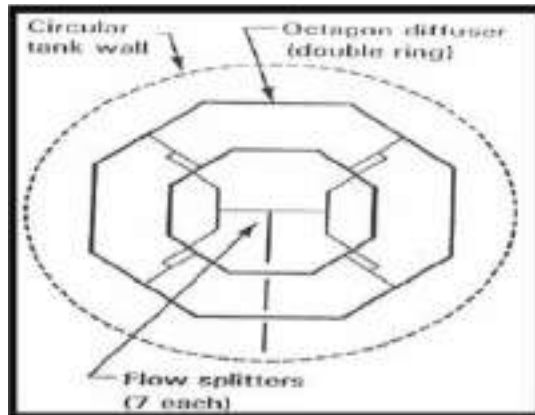
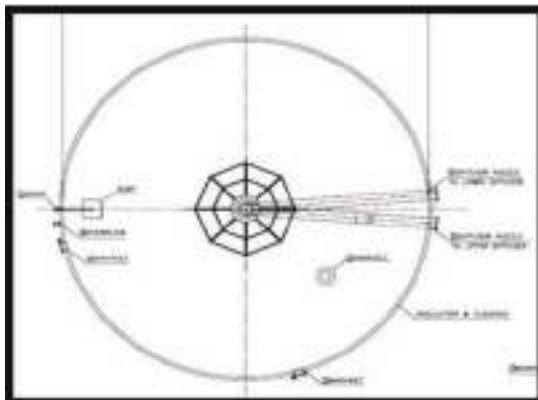
applications. When used in large industrial facilities, on university or healthcare campuses, in district energy projects, or on military bases, a Chilled water TES system can save you millions of dollars in life cycle costs.

CHW - TES System will save you money by:

- Reducing annual energy and operational costs
- Deferring capital expenditures on equipment replacement of expansion projects
- Preventing downtime of mission critical operations
- Improving the efficiency and power output of natural gas electrical power generators
- Acting as a negotiating tool in deregulated markets

Benefits

- Lowest initial investment cost
- 30% energy saving by utilizing conventional chillers



whose efficiency is higher than low temperature chillers.

- Simple System with easy control without additional heat exchangers and less equipment.
- Efficiency of discharging coldness is very high
- Easy to convert conventional system into CW TES system by adding only chilled water storage tank.
- Convertible to heating purposes.
- Environmentally friendly system free from brine.
- Storage water can be utilised for fire fighting in emergency.
- Quick response to the cooling load ■



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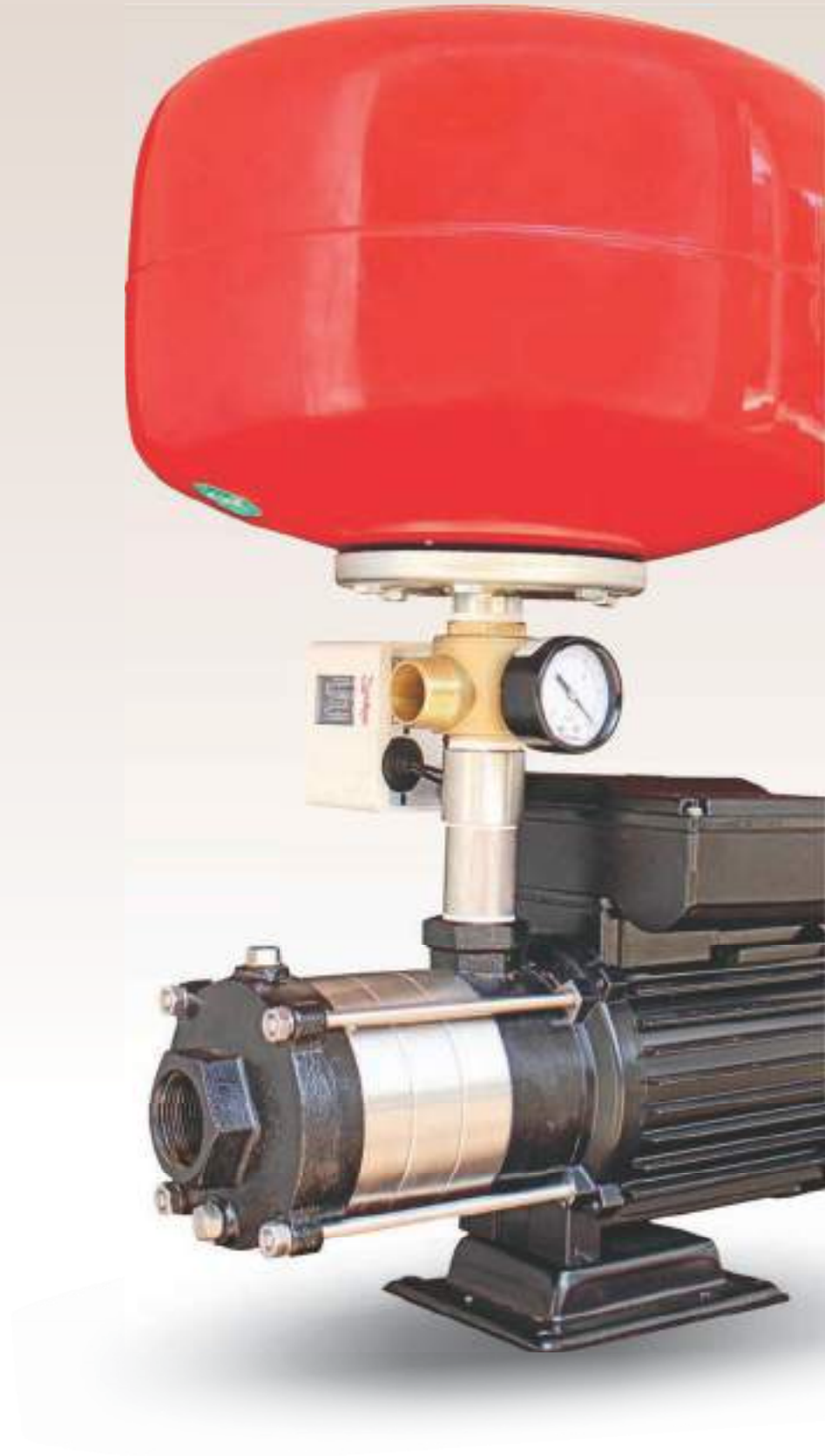


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Grundfos Remote Management

Bringing Pumps Online

A Building Management System (BMS) or a (more recent terminology) Building Automation System (BAS) is a computer-based control system installed in buildings that controls and monitors the building's mechanical and electrical equipment such as ventilation, lighting, power systems, fire systems, Plumbing System and security systems.

A Building Management System consists of software and hardware - the software program, usually configured in a hierarchical manner, can be proprietary, using protocols such as C-bus, Profibus, etc. BMSs can also be integrated using Internet protocols and open standards such as DeviceNet, SOAP, XML, BACnet, LonWorks and Modbus.

Why BMS in commercial buildings

Building Management Systems are most commonly implemented in

commercial building for monitoring and controlling HVAC, electrical, and plumbing systems. Systems linked to a BMS typically represent 40% of a building's energy usage; if lighting is included, this number approaches 70%. BMS systems are a critical component to managing energy demand. Improperly configured BMS systems are believed to account for 20% of building energy usage in any commercial buildings.

In general in any commercial buildings, BMS is used to monitor and control the below systems:

- Heating Ventilation and Air-conditioning (HVAC)
- Fire System
- Plumbing System
- Illumination (Lighting) control
- Electric power control
- Access Control
- Alarm Annunciation
- Security Automation &
- Other Engineering System.

M Manimaran, an Electronics & Communication Engineer & MBA, Anna University has worked in various Industrial automation & Power projects in Instrumentation and Process Control Engineer before joining Grundfos pumps as Engineer – Sales for Sensor business; then as technical support all India for HVAC systems; now working as Senior Engineer Business development, for commercial buildings. He is a member of ISHRAE.



them less flexible. Initial investment is high in terms of monitoring and controlling the systems in the buildings.

Commissioning

- Allocation of space for having BMS room for all hard ware items.
- Installation of server hardware for storage and back up data requires separate room.
- Periodic maintenance of server is mandatory.
- For hardware and software communication the cables needs to be laid from different location of the buildings to the server room.
- Competency of commissioning engineer.
- Issue in inter-operability, since all the system in the buildings may not have same communication protocols and data formats.

Testing & Verification

Before startup involves high procedure of testing, validation, and documentation in man power and cost.

Maintenance

The maintenance of the server for backing up the data's need extra man hours and cost.

Dedicated man hours for monitoring and controlling any system components is mandatory at all times in BMS room. Requires customer to host and maintain the BMS system.

Optimising pumps & pumping system through – Internet based remote monitoring system

Introduction to Grundfos' Remote management

Grundfos remote management is a cost-effective, secure and reliable way to monitor and manage pump installations from an internet PC at a very low price.

Grundfos remote management is a straight forward way to monitor and manage pump installations in commercial buildings and in water supply and waste water infrastructure.

It reduces the need for onsite inspections and in the event of an alarm or warning, the relevant people are notified directly. Compared to mobile phone-based monitoring, the system offers a wider range of benefits and functionalities. For those who do not require remote process automation, Grundfos Remote Management is the ideal solution for monitoring and remote control as opposed to traditional SCADA (Supervisory Control and Data Acquisition) systems. Initial investment is minimal, and a fixed low fee covers data traffic, hosting costs and system support, including back-up of all data.

It provides remote access to data and alarms from pumps, pump controllers and auxiliary equipment like sensors and meters. Data from pump installations is transferred to a central database and published to subscribers on a secure web server. Users have access to data from pump installations that are registered to their own account.

Complete performance data available allows optimisation of system and as well to plan the service and maintenance program of the system.

GRM System overview and its key features

- Complete status overview of the entire system being managed
- Live monitoring, analysis and adjustments from the comfort at desktop
- Follow trends and reports to reveal opportunities for energy-reducing performance optimization
- Alarm escalation on schedules
- Plan service and maintenance based on actual operating data

Hurdles in implementing and maintaining a BMS system

Implementation of BMS in any Commercial Building follows below procedure:

- System Design and Functional Specification
- Commissioning
- Testing & Verification
- Maintenance.

System Design & Functional Specification

Based on the system objectives and deliverables, a detail schematic, test plan, and functional details need to be decided. Also, the monitoring & interrogation design and user interface graphics and displays need to be designed. Space for server room for data collection must be considered as per the requirement. BMS systems have limited input and output speeds. Due to the lack of programming flexibility, the object-oriented design of BMS system makes



- Share system documentation online with all relevant personnel
- Centrally hosted database and application server.
- Users only need an Internet PC and a contract with Grundfos
- Web access to reports and trend data for all relevant employees
- Secure data channel (SSL 256 bit encryption – through https://:)
- Wireless communication from pumps to server
- Customize user interface with graphics or pictures
- A fixed low fee covers hosting and full IT support
- Account is secure via User-ID and password
- Monitor any pump, meter, sensor or switch via extension interfaces.

Be the first to know

Easy and cost effective monitoring and management of critical installations.

If anything needs attention, you will be the first to know.



Grundfos Remote Management offers you a complete overview of your pumping systems and lets you be online with your pumps. You can monitor energy consumption, share documentation, manage service and maintenance, and maintain a flexible on-call schedule. All this is part of a highly secure network hosted from Grundfos and these services are supplied with full IT support.

Grundfos Remote Management offers many advantages for managing your critical installations:

- Building installations: HVAC, fire protection units & Hydro Pneumatic systems are monitored and managed from a central location, ensuring and documenting services to building users. Daily usage pattern can be logged and can be used as a tool to reduce water as well as electricity consumption.
- Wastewater pumping stations: Monitor standard wastewater pumps, sensors and controllers of any make and model, including automatic reports of operational data.
- Water treatment plants: Monitor flow and pressure sensors, tank levels, pumps and security alarms, including automatic reports of power consumption and operational data.
- Mines and construction sites: Receive alarms from dewatering pumps immediately in the critical event of breakdown or malfunction.
- Irrigation: Monitor tank levels, pressure gauges and pumps to be sure crops and livestock always have enough water. Ideal fit for farm houses and weekend homes system management.

A precise picture

A full overview of the operation, performance and trends:

Overview

Complete overview of the status monitoring, analysis and entire system you manage.

Share documentation

Upload system documentation to secure server and make it accessible to all relevant personnel.

Online with your pumps

Live adjustments from the comfort of your office.

Flexible on-call schedule

Simple planning of who responds to alarms in rotating weekly schedules.

Monitor energy consumption

Trends and reports may reveal opportunities to reduce energy consumption and optimize the performance of the systems.

Manage

Plan on the basis of actual operating data and get notification when service is due.

Conclusion

Grundfos Remote Management is a cost effective solution for monitoring and controlling pumps & pumping systems at Residential buildings, small and medium size commercial buildings, agriculture irrigation, water treatment & waste water pumping stations, where a user cannot afford high investment in BMS/SCADA. ■

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Low Energy Air Conditioning for Buildings



Over half of global warming is thought to be attributable to the burning of fossil fuels and slightly less than half of this is due to conditioning the environment within buildings.

Since major governments are committed to reducing carbon dioxide emissions by 20% by the end of 2020, the pressure to improve the energy efficiency of our building stock is likely to increase in the coming years.

Field studies have identified that, on an average, fuel costs for air conditioned buildings are twice that of naturally ventilated buildings and result in twice the generation of CO₂ emissions.

Air conditioning is therefore often thought of as an environmental evil by environmentalists with calls to ban it. Air conditioning protagonists argue that air conditioning provides for a better environment within buildings and only accounts for 6% of CO₂ emissions in commercial and public buildings however some of the issues explored here that impact on the design of energy efficient air-conditioned buildings are based on research carried out by professional involved in the design and commissioning of a new building or refurbishment of existing buildings.

Why Air Conditioning!

Air conditioning provide cleaner air, reduce externally generated noise and control humidity and temperature. In theory, the increased energy use of air conditioning can produce better environmental control, which in turn may improve the health, comfort and productivity of occupants. The problem appears to be that in many cases air conditioning has not resulted in an improved, environment, but has resulted in increased energy consumption.

Most museum objects require a stable humidity to prevent object deterioration. Theoretically visitor comfort is also to be considered and achieved, for stable humidity can not be achieved by heating alone but requires dehumidification and humidification. In addition, many museums are located in polluted inner

city areas where the objects need to be protected from the potentially corrosive external environment. The introduction of full air conditioning in such buildings provides the potential for improved humidity and pollutant control.

However, the monitoring of relative humidity in different museums suggests that the variation in humidity can be as large in air conditioned galleries as in naturally ventilated galleries. mechanical ventilation controlled by carbon dioxide sensors plus humidification and dehumidification within the gallery space. variation in RH, to which objects may acclimatize, are short-term variations. Interestingly, the smallest variation that occurred in any week was in the naturally ventilated gallery since achieving good humidity control is difficult in museums for the following reasons:



Norman Dsouza, Sales and marketing director, actively involved in propagating integral approach to design in construction and maintenance of buildings, having direct impact on environment and natural resources.

- The level of control required is not typical of other buildings
- The spaces requiring conditioning are often large in volume
- The internal gains can vary dramatically.

Budgets for the operation and maintenance of museums are very much limited. Also, gaseous and particulate pollutant measurements in both naturally ventilated and air conditioned museums show that only some of the potentially harmful pollutants are significantly reduced in air-conditioned museums.

Therefore, in practice, air conditioning may not provide a significantly better environment for the display of objects. Yet the energy consumption of air-conditioned galleries is twice that of naturally ventilated galleries. Although energy costs in real terms are at their lowest level for over 20 years and for many organization energy costs are an insignificant element of a company's operational cost. However, many organization are unaware of the expenditure required to properly commission, operate and maintain an air conditioning system. Without this investment air conditioning will not produce the controlled environment expected of it. Clients need to be made aware that, over the predicted lifetime of services; the capital outlay may account for only one-third of the total cost, the other two-thirds being accounted for by maintenance and operating costs. Although it is often stated that services may account for 40% of the total capital cost of a new building, which totals to 90% of the lifetime cost of a building.

Cost Effectiveness

During the design of energy efficient building there are many opportunities to invest in energy efficiency. Often these investments are simply dismissed as too expensive, occasionally, however, pay back calculations are carried out to determine if the investment is cost effective. What determines whether a particular investment is cost effective or not will vary from client to client. For example, an environmental organization

may accept a payback time of 20 years during the design of their headquarters, whereas a commercial company commissioning a superstore may only consider payback times of less than 6 months. However designers should also be aware of the non-energy saving benefits of some energy efficient technologies, as it is often these additional benefits that sell a particular energy technology to a client. For example, the installation of double-glazing is one of the most popular energy saving technologies in the domestic market. Yet it has one of the longest paybacks times ranging from 10 to 30 years. The reason for its popularity is that double-glazing has many benefits beyond simple energy efficiency. These include the following:

- The lack of surface condensation and hence improved visibility and reduced maintenance.
- A perception of improved security.
- Improved thermal comfort close to the glazing due to higher internal surface temperatures.
- Improved noise reduction.

The energy measures most often adopted during cost analysis are those which have benefits additional to simple energy efficiency. For example: High frequency lights have been shown to reduce the incidence of headaches and eyestrain. Automatic control of electric lighting when day-lighting is adequate can reduce overheating and hence improve occupant comfort. External insulation can eliminate cold bridges and protect the fabric.

Very often such measures will be adopted even though a simple energy payback calculation may identify them as not being cost effective. Therefore, designers should be fully aware of these additional advantages of energy efficient technologies to increase the likelihood of them being accepted.

There is a tendency among designers to be followers of fashion when adopting energy efficiency, and in particular adopting a center piece or energy efficient statement, normally a visible feature. For example, large areas

of south facing glazing, solar chimneys and photovoltaic cells are popular "green" statements. Monitoring building energy use has shown that, buildings which focus their energy attention on one particular issue, are often not energy efficient in practice. Energy flows within air-conditioned buildings are complex and many faceted, All the different forms of energy use in a building must be considered if the overall performance of the building is going to be energy efficient. The introduction of a nationally agreed non-domestic energy-labeling scheme would assist this process and allow clients to take more informed decisions.

Not only do the various energy efficient technologies have to compete for limited funds against inefficient technologies, but also against themselves and renewable energy technologies. Although, design teams often argue that PV's may be competitive against fossil fuel in the long term as fossil fuel prices rise, they should also be aware that renewable have to compete against other energy efficiency measures and it may be far more cost effective to invest in fabric improvements, energy efficient fans or lights than say PV's talk about typical payback periods and the cost effectiveness of different measures per tonne of carbon saved for different fabric energy improvements, service improvements and renewable technologies in the domestic an commercial stock. Sometimes however, the primary aim is to make a visual statement, i.e. an advert for the company, in which case the design team should be aware that this is the primary reason for implementing that particular technology.

Integrated Design

Somewhat, once the decision that air conditioning is going to be installed in a

building has been taken, professional roles seem much simpler. The principles of integrated design, which all designers are aware of, too often seem to be forgotten. Without integrated design the architect can simply design the fabric focusing on the aesthetic and structural properties. The services engineer can then fix the environmental control in the building! We all know that it should not be like that. Yet this still occurs in many projects, after all it can suit all parties. Architects can get the building to look just how they want to, while the services engineer does not have to get involved in complex debates with the rest of the design team.

The services engineer can simply design a system for a building where all the fabric variables have already been fixed, making the whole process less time consuming. There really is no motivation for the engineer to reduce the capacity of the installed plant when their fees are related to the cost of the plant. The net result can be an air conditioned building which uses far more energy than is needed, at the same time as making the system more complex to operate and maintain. If the occupants cannot afford to maintain or operate such systems adequately, the benefits in improved environmental control are lost. In extreme cases the lack of integration in the design team between the design of the fabric and services can result in the fabric failing. For example, a recently designed award-winning museum has never achieved the level of environmental control required, uses excessive energy and has water condensing on walls and windows.

Meanwhile the occupants think that better environmental control would have been achieved in a medieval building with earth floors. The advantages of an air conditioned building which incorporates the principles of integrated design go beyond simple energy saving. For example, when the plant fails – invariably on the hottest day or over the winter period, the consequences are minimized in a building where both the fabric and services act to control the environment.

Form

The importance that form has on deciding, whether a building is air-conditioned or not is very important and reasonably well understood, by the impact that form and fabric can have on the annual energy consumption of air-conditioned indicates that a change in aspect ratio for an air conditioned building from 1:1 to 6:1 increases primary energy consumption by only 1 to 1.5 %.

Robust Solutions

Energy monitoring within buildings designed to be energy efficient often shows that the building uses far more energy than expected. The reasons for this discrepancy are many, including the following:

- Energy efficient features left out during the latter stages of construction due to cost cutting even though the initial design strategy was dependent on a system being installed.
- Inadequate commissioning.
- Complex design.
- Occupant use different from original design assumptions.
- Inadequate resources and expenditure on operation and maintenance.

Energy efficient designs must be robust enough to cope with the range of conditions that the building will experience over its lifetime. In particular systems designed today should be able to cope with the impacts of climate change and changes in occupant use.

Climate Change

Although the evidence for global warming is still controversial, the majority of world climate experts now agree that global warming will occur and there is growing evidence that it is already happening and during the last 20 years the average monthly degree day to base 15.5°C has decreased by some 11%. Total cooling degree-hours to base 18°C have more than doubled on average for most locations over the last 35 years. Designers should at least examine the impact that such warming may have on the comfort of occupants and the energy consumption over the lifetime of the building.

Occupant Use

During the design of a building many assumptions are made about how the occupants will interact/use the building. Given such assumptions it is possible to model how a building will perform. However, many designs are very dependent on occupants using a particular space in a certain way, or controlling various elements of the building and its services in a particular way. If the real occupant's behavior differs from the original assumptions, then the building can often perform differently from the original design intentions. Three examples of this are as follows:

- **Atria and glazed walkways:** These are very often designed to be energy efficient features allowing daylight and enhanced ventilation to penetrate a building. During the design the assumption is that the spaces are treated as buffer spaces and so are not actively conditioned i.e. treated as uninhabited zones. The reality is often very different. Because such spaces are very often attractive, the tenants want to make use of them all year round in a similar way to other spaces within the building, e.g. as meeting areas, restaurants, classrooms etc and as such they require extensive conditioning. So what was initially planned as an energy saving feature turns out to be an energy-guzzling feature. Further, had the original design assumed the space was to be fully conditioned it would have probably been designed differently. Similar results have been found in the domestic sector where 90% of conservatories are in fact heated.
- **The use of Venetian blinds:** Heavily glazed facades can allow daylight to reduce the need for electric lighting. However they can also result in high solar gains. Blinds can assist in allowing adequate daylight while reducing solar gains and glare. The assumption often made during the design is that during overcast periods the blinds are pulled up, or at least the slats are in the open position, and that

during sunny periods when cooling or shading is required, they are pulled down and their slats are in the closed position. The reality is that on average some 40% of the glazed facade is excluded with blinds and that there is relatively little adjustment due to variation in solar gain.

- **Controls:** Buildings which require sophisticated controls, also require sophisticated controllers and in turn these require knowledgeable operators. If the occupants of the building are unlikely to have adequate knowledge, or cannot afford to buy in the necessary expertise, systems should be kept simple. However, the above areas all require further research, in particular there is a need to test the sensitivity of different design strategies to different assumptions about occupant use in order to assess the robustness of the various options.

As a result of such work it is expected that several strategies currently thought of as energy efficient will be found to be inefficient.

Conclusions

The design of energy efficient buildings is far more complex than was originally thought in the 60's and 70's. In particular, theoretical energy savings do not always materialize; similarly installing more plant does not always result in improved occupant comfort and environmental control.

Energy efficient design has now moved beyond the simple theoretical analysis of predicted savings to the adoption of proven techniques, based on the results of monitoring buildings over the last 20 to 30 years. In particular, the importance to detail throughout the design process, and the role of good commissioning, operation and maintenance have been identified. Where appropriate, air conditioning

should be incorporated in the design and not treated as an unnecessary evil. Clients should however be warned of the operating and maintenance costs and designers should be realistic as to the environmental benefits that will materialize.

The design team needs to strive for an integrated design minimizing the degree of active control of the environment and maximizing the passive control features even if air conditioning is to be installed. The overall system design should be robust to future climate change and changes in occupant use. Also, the energy strategy for a building should rely on more than token visual statements or single elements of energy efficiency and should cover all aspects of energy use within a building. The introduction of a national energy labeling system for non-domestic buildings could play a significant role in making sure this is the case. ■

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Energy savings in fans... What's so EC about it!



Atul K Tripathi, Managing Director, ebm-papst India Pvt Ltd, in an exclusive interview with **Cooling India** remarks, let us know more from ebm-papst, the world market leader in EC Technology.

Tell us about ebm-papst GreenTech EC technology.

With world's widest range of fans and motors and having a sales turnover of over 1.5 billion Euros, ebm-papst is world market leader in EC technology.

ebm-papst developed compact fans in EC/DC technology way back in 1965. An EC motor is a brushless, permanent magnet, synchronous motor with electronic commutation, we just named it "Electronically Commutated motor" or "EC motor".

The GreenTech idea reflects a simple but clear philosophy that goes back to our company principle: "Each new product that we develop has to be better than its predecessor in terms of economy and ecology."

ebm-papst has over 14,500 active fan models. Year after year, we input a great deal of knowhow, commitment and great inventiveness to redefine standards with even more powerful and efficient motors and fans that raise the bar ever higher, step by step, often even in giant leaps.

In which business segments EC solution is provided by ebm-papst?

ebm-papst has very diverse product portfolio. Some of the major business segments include Ventilation, Air-conditioning, Refrigeration, IT / Telecom, Automotive, Rail technology, Renewable Energy – Solar PV, Wind and Mechanical & Industrial segments like Medical equipment, Printing, Transformer cooling, etc.

To give the highest level of service, we involve ourselves in depth with the industry, its basic

conditions and areas of potential. Our objective after all is to stay attuned to trends, recognize demand and thus to be successful along with the industry.

Tell us about ebm-papst's operations in India

ebm-papst started its operations in India in 1996 as a Joint Venture with ebm-papst holding majority stake. In the year 2009, it became a 100% subsidiary of ebm-papst, Germany.

ebm-papst India has 2 manufacturing facilities, around 300 employees, 7 sales offices, 4 warehouses across the Country.

At ebm-papst India, we produce various sizes of AC/DC and EC fans.

How do you see EC technology in Indian market?

EC technology is not new to India, as ebm-papst has been supplying EC fans for the past 15 years in applications like precision AC, clean room, IT/telecom, renewable energy etc.

As we know, India is a power deficient country with very high cost of energy. The customers and influencers are highly knowledgeable and look at the Life Cycle Cost of the system instead of merely the CAPEX.

With this increasing level of awareness, we are already supplying EC fans to other major applications like AHU, Chillers, FCUs, etc. The demand is not only in the new projects, but also in the retrofits of existing products. We have a well-trained team of application and project engineers in India, backed by the German engineering team to support the customers.

ebm-papst GreenTech EC solution has the widest range from 10 Watts to 12.0 kilo-Watt EC motor to provide the most optimized solution for various applications.

What are your latest innovations in your product portfolio?

Innovation is a continuous process at ebm-papst. One of our recent successes is RadiCal fans. This patented RadiCal design has far superior aerodynamic properties which results in higher efficiency, lower power consumption and noise levels.

For the AHU, ebm-papst is very successful with its widest and highly efficient RadiPac range that offers plug-and-play solution. Furthermore, in order to provide a one-to-one retrofit with DIDW blowers, ebm-papst has introduced its all new RadiFit range.

To further improve the overall energy efficiency and noise behaviors in Chillers & AHUs, ebm-papst has introduced highly innovative products like AxiTop and FlowGrid.

For calm hotel rooms, ebm-papst has developed energy efficient EC blowers with excellent noise behavior for the fan coil units. Please check the experience of our offering to the hotel industry at www.hotel.ebmpapst.com

In line with our EC GreenTech philosophy, ebm-papst will be unveiling a new range of EC products at the upcoming ISH in Frankfurt in March 2015, which will set yet another new benchmark in total efficiency & noise levels in the Industry. ■

The ebm-papst Group is the world's leading manufacturer of fans and motors. Since it was founded the technology company has continuously set global market standards. These developments range from electronically controlled EC fans to aerodynamic improvements to fan blades, to resource-conserving selection of materials, including bio-materials. In the fiscal year 2014-15, company achieved a turnover of just under €1.5 billion. ebm-papst employs around 11,000 people at 18 production sites (including in Germany, China and the USA) and in 57 sales offices worldwide. Its fans and motors are used in many branches of industry including ventilation, air conditioning and refrigeration technology, household appliances, heating systems, IT and telecommunications, as well as automotive and commercial vehicle applications.

HANNOVER MESSE 2015: Get New Technology First Government announces big subsidies to Indian Participants

India has been named official Partner Country for year 2015 edition of the world's leading industrial trade fair. Together with **German Chancellor Angela Merkel, Prime Minister Narendra Modi** will officially open HANNOVER MESSE 2015 on the evening of 12 April, then take part in the traditional opening day tour on 13 April. India's role as the Partner Country at HANNOVER MESSE underscores the new Indian Prime Minister's ambitious economic course. Under the slogan of "Make in India", Modi is promoting the modernization of India's factories and infrastructure and greater foreign investment in local production. Modi is convinced that production industries form backbone of Indian economy.

Electrical India, a publication from India would be present to promote Make in India brand at HANNOVER MESSE 2015, Germany during April 13-17, 2015. The event will comprise following ten flagship fairs.

- Industrial Automation
- Motion, Drive & Automation (MDA)
- Energy and Wind
- MobilTec and Digital Factory
- ComVac



What India Achieved During Previous Partner Country					
Total Business Generated worth			1.3 Billion \$USD		
Spot Orders Booked worth			15 Million \$USD		
Enquires worth			100 Million \$USD		
Highlights of Previous Show (7-11 April 2014)					
Trade Visitors			180,000 (100 different nations)		
Highly qualified visitors from all across the Globe					
69% Europe	19% Asia	8% South and North America	3% Africa	1% Australia Oceania	64% Decision Makers
4.2 Million Business contacts in 5 days					

- Industrial Supply
- Surface Technology
- Research & Technology.

India, a nation with over 1.2 billion inhabitants, will be at the focus of the world's leading industrial technology show. Last year the German Government approved loans amounting to approximately €1 billion. This money will be invested in energy efficiency, renewable energy and the sustainable use of natural resources. Exhibitors from Germany and other countries will encounter Indian visitors who want to invest in modern technology in order to strengthen their nation's economy. ■

Growth of HVAC Industry in India



In India, Air-conditioning industry is approximately around 65 years plus old. Earlier most of the air-conditioning equipment were assembled and sold (till mid 1950s).

For over a decade, India has been witnessing continuous growth. Due to developments of commercial, residential areas, hospitality, industrial applications including high rise buildings, requirements of specialized allied building services like air-conditioning & ventilation, fire & safety and plumbing are much more demanding, requiring a higher level of engineering and co-ordination between all the services. Expansion of commercial space, more offices and corporate hubs coming up, and introduction of organized retail outlets even metro rail network are driving the demand for HVAC installations across the country. In addition to shopping malls and retail complexes, airports are also emerging as important centers for HVAC installations in the country. HVAC systems have become one of the core building blocks for modern infrastructure, encompassing various sectors like real estate, etc. All

these factors are expected to spur the market for HVAC systems in India. Today air-conditioning has become a need of modern day life in contrast to its earlier perception as luxury '6-8 years back which is almost a necessity' now. That has give a boost to the industry to reach Rs 10,000 Crore mark by the end of the year 2010.

In green building energy conservation, indoor air quality, and comfort are among the core issues encompassed by heating, air-conditioning and ventilation design that are largest consumers of energy in buildings (upwards of 40-50%). Green building achieves high performance in the following areas:

- Minimal consumption of energy – due to reduction of need and more efficient utilization- of non renewable natural resources, land, water, and other materials as well.
- Minimal atmospheric emissions having negative environmental



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Dr Namita Joshi is Head and incharge of Department of Environmental Sciences, Kanya Gurukul Campus, Gurukul Kangri Vishvidyalaya, Haridwar. She is PhD with specialization in Fisheries and Crustacean Toxicology with 26 years of research experience and 21 years of teaching experience. She has published more than 75 research papers and supervised more than 195 MSc dissertations and guided to 10 PhD students.



Dr KK Gangwar is PhD with specialization in Ecology and Biodiversity and working as an Environmental Consultant. He has published 4 books, more than 28 international and national research papers, newsletters and various book chapters on several aspects of environmental sciences. He is a fellow of Indian Academy of Environmental Sciences (IAES), Haridwar and Life member of Society of Environmental Sciences, Dumka.



impacts, especially those related to greenhouse gases, global warming, particulates, or acid rain.

- Minimal discharge of harmful liquid effluents and solid wastes, including those resulting from the ultimate demolition of the building itself at the end of its useful life.
 - Minimal negative impacts on site ecosystems.
 - Maximum quality of indoor environment, including air quality, thermal regime, illumination, acoustics/noise, and visual aspects.
- Efficient HVAC Systems.

The HVAC system for green building shall be designed to reduce energy consumption while maintaining the interior conditions at a comfortable level to keep occupants health & productivity. The designer should ensure the HVAC system design NOT only meet the standard on energy front but beat the standard codes like Energy Conservation Building Codes (ECBC), India & American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE) standards to achieve higher level of green building LEED (Leadership in Energy and Environmental Design) rating. For energy efficient building and energy codes, key elements to ensure

that the mechanical systems designed are efficient include:

- Requirement of minimum equipment efficiencies for all installed equipment
 - Proper equipment sizing & selection
 - Minimization of distribution losses by requiring duct insulation, sealing and piping insulation
 - Installation of controls to give occupants ability to operate the systems in an efficient manner
 - Cooling utilizing conducive ambient conditions to reduce cooling energy
- Indian HVAC Market.

The Indian HVAC market is growing at a rapid pace mainly contributed to the huge rise in construction activity in the domestic real estate market. According to an estimate by Indian Society of Heating, Refrigerating and Air Conditioning Engineers (ISHRAE) the HVAC products market in India is valued around Rs 15,000 crore, having grown from Rs 10,000 crore valued industry in 2010 and is expected to grow by nearly 30% over the next two years to boast of a capitalization of over Rs. 20,000 crore, which will be mainly due to the buoyed acceleration in infrastructure and real estate sectoral activities.

A recent report "India HVAC Market

Forecast & Opportunities, 2019" has been published by TechSci Research. It has evaluated the future growth potential of the HVAC market in India and provides statistics and information on market structure, market trends, market size & share, etc. The report includes HVAC market projections and demand forecasting. The report is intended to provide cutting-edge market intelligence and help decision makers take sound investment evaluation. Besides, the report also identifies and analyses the emerging trends along with essential drivers, challenges and opportunities available in the HVAC market in India. According to this report, the HVAC market in India is forecast to reach US\$3.97 billion by 2019 on account of changing lifestyle, increasing per capita income, and rising expenditure by consumers on comfort solutions. 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. Due to which the Indian retail market is projected to reach US\$726.62 billion by 2019, which is expected to further fuel the country's HVAC market. Major companies offering HVAC systems in the Indian market are Daikin, Blue Star, Voltas, Carrier and ETA. However, with the rising demand for energy efficient products in the country the HVAC market is expected to undergo significant brand shift over the coming years.

In the Union Budget 2014 food safety was focused to some extent. Food safety and food preservation is also associated with growth of HVAC industry. While increasing investment in scientific warehousing to Rs 5000 crores is a very positive step. Independent research reports suggest India's high energy costs as a deterrent for private players from investing in cold storage units given its power consumption. A typical cold storage of 5000 ton capacity costs around 12 crores which uses dated technology, especially the systems which can be automated. An automated cold storage with best global technologies will cost 30% more. It is important to note that 60% of the operating cost of a cold storage is due to electricity and this cost could be anywhere close to 1.5 crores per annum.

Business analysts Frost & Sullivan has also published a report which states that the total select HVAC products market was valued at Rs 31.71 billion in 2010, and is expected to grow at a compound annual growth rate (CAGR) of 16.9% till 2015, owing to the rapid growth in the construction sector. In volume terms, it is expected to reach approximately five million TR in 2015. While the Indian Central AC market is currently estimated at \$765 million, it is expected to reach \$2295 million by 2015.

By analyzing the investment spends in user industries (such as real estate, hospitality, education, healthcare, power, etc) Emkay Research forecasted an opportunity of Rs 721.5 billion for the domestic MEP industry for the next 4 years (FY12-16E period). However, at Rs 262.9 billion, the HVAC opportunity is 5.0X the current industry size of Rs 53 billion or 36% of the total opportunity indicates maximum contribution by

Metro rails (46%), followed by commercial real estate (20%), education (21%), hospitality (7%), retail (3%), healthcare (2%) and Airports (1%).

Snapshot (In Rs million)	HVAC
Commercial	51467
Retail	8720
Hotel	19048
Hospitals	6264
Power	0
Education	54331
Airport	3000
Metro	120023
Total	262853

Table 1: Opportunity for the HVAC industry over the next 4 years during FY12-16E period

Due to the slowdown in the building construction industry, some of challenges being faced by HVAC industry are deferment, postponement and even cancellation of projects, drying up of finance, below-cost bidding, pressure for cost-cutting, spending freeze and the looming specter of funding crisis due to the prospect of lesser number of construction projects being sanctioned in the near future.

Some of the other major challenges faced by HVAC industry are:

- Projects are not executed properly with the first time right concept.
- Research to have a cutting edge technology and training to hone skilled manpower is not given its due importance.

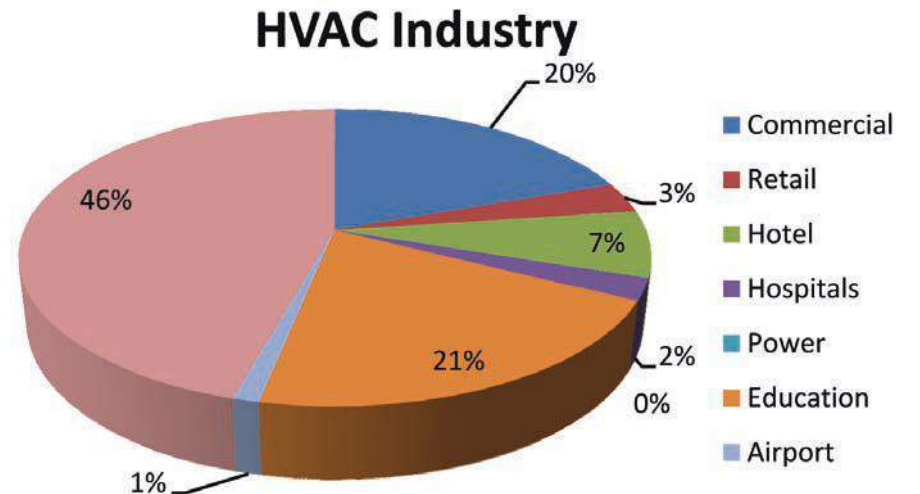


Fig. 1: Opportunity for HVAC industry indicating maximum contribution by different sectors

Current challenges facing HVAC industry

The HVAC industry is currently facing a lot of challenges because of its major aims to provide cost-effective solutions that cater to the needs of the commercial and industrial customers by introducing eco-friendly systems. With energy conservation and implementation of greener measures being one of the major standouts of the industry, the move away from non-greener refrigerants towards more sustainable technologies is being seen as a major demand driver in the industry; one that will set forth a future course of action for the industry.

- Proper guidelines or standards tropicalised for India seldom exists.

Solutions to these challenges

Integrated approach with all the stake holders right from owners, developers, architects, consultants, project managers, manufacturers, contractors, facility managers is required to achieve the various objectives. Solutions to these challenges are:

- Focus on the life cycle cost (which is installed cost, operation and maintenance cost) instead of the first cost.
- Energy efficient products are to be sourced even though it may be marginally expensive to start with,

good study on the life cycle cost and the Return on investment will save the country from current energy crisis as 'one unit saved is two units produced'.

- Projects need to be executed properly with a good planning, deputing right resources and dedicating time and importance as required.
- The quality and specifications shall not remain on paper and has to be displayed during execution.
- A project executed well will maintain comfortable conditions without overcooling and shall have lesser failure rates with enhanced life.
- Standards, codes, guidelines totally tropicalised for Indian scenario are to be available in all the possible areas.
- Certification of engineers, technicians and operators is the need of the hour and such requirement is not present as of now.
- Air-conditioning is made the reason for spread of fire and indoor air

quality issues. But a correctly designed and executed project will not only maintain the right design conditions and good indoor air quality. It will also help in safe exit of human beings in case of fire with extensive smoke management systems.

- Standards and codes are to be tropicalised to meet present scenario with more practical approach.

Estimated future industry growth

Everybody knows that HVAC systems are becoming one of the key building blocks in modern infrastructure. Economic growth, increase in construction activities are resulted due to rise in infrastructure, rapid urbanization and growth in commercial properties in turns fuelling the market for HVAC systems in India. With healthy growth anticipated in the real estate sector, the country is expected to witness strong infrastructure development,

which would boost the market for HVAC systems over the next five years.

India is known for intellectual skill set and this will attract all investments from each and every corner of the world. Infrastructure and hospitality industry, information technology sectors growth is appearing positive – this will propel the HVAC Industry and growth rate can be as high as 20 per cent. According to the Bureau of Energy Efficiency, the overall constructed area of the building sector in India will be 9,670 million sqm by 2030; which includes offices, retail, hospitality, and residential segments. This potential demand from the construction sector, coupled with the potential to save energy from air-conditioning, will lead a boom period for the HVAC industry by 2035, with complete support from the Government to promote energy-efficient standards, practices, and technologies. Besides refrigeration has to be given importance – it can surpass the HVAC industry in a decade or so. ■

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Six Data Center Trends to Watch in 2015

Emerson Network Power, a business of Emerson identified six data center trends that will grow in importance in 2015 as data center operators seek ways to respond to dynamic market conditions quickly and efficiently.

Steve Hassell, president, Data Center Solutions at Emerson Network Power says, "Data centers are undergoing fundamental changes as management shifts their focus to issues such as speed of deployment, manageability, scalability, efficiency and security. They are seeking innovations that give them the agility they need to respond to changes both in the data center ecosystem and in the markets they serve."

Following are the six trends that are shaping the decisions data center designers, operators and managers are making.

Cloud computing

Cloud computing has become established in data center ecosystem as most organizations already use some form of software-as-a-service (SaaS). Now cloud is poised to expand from that foothold and become an engine of innovation. Forward-thinking organizations are combining cloud-based services such as analytics, collaboration, and communication to better understand their customers and bring new products and services to market faster. The result is that a growing number of organizations will be managing hybrid environments in which on-premise IT resources are supplemented with strategic use of cloud and colocation services to enhance utilization, resiliency and flexibility. For their part, cloud providers must demonstrate the ability to scale quickly while consistently meeting service level agreements, in order to thrive in an increasingly competitive environment. Cloud providers will drive innovation in the industry as they adopt technologies and practices that achieve high reliability at the lowest possible cost.

Integration

Integrated systems were developed to help organizations deploy and scale applications faster while reducing risk and total costs. With rapid changes in many markets being driven by innovation, digitization and mobility, the need for speed that integration and convergence delivers is greater than ever. As a result, integration and convergence has expanded beyond the IT stack to the systems that support that stack. Most notably, data center facilities are now being designed and constructed from integrated, prefabricated modules. Combining the attributes of fast deployment, inherent scalability & excellent performance, this approach is becoming an attractive alternative for supporting additional IT capacity.

Convergence

Technology systems aren't the only things experiencing a convergence. The telecommunications and IT industries are moving closer together as voice and data services are now routinely consumed on the same device. In fact, more than half of the participants in the Data Center 2025 project predicted that at least 60% of telecommunications network facilities will



be data centers by 2025, and 79% expect at least half of telecommunications companies to make colocation facilities part of their networks. This convergence will drive more standardization in the technologies used to support voice and data services and break down the silos that have traditionally existed between these two critical functions.

Software paves way for more software

Virtualization marked one of the most significant trends in the data center industry in the last twenty years. The impact of this development will continue to drive change for the foreseeable future as virtualization extends beyond computing to networking and storage. One of the key challenges in this virtual revolution is going to be hardware management. Most organizations lack the visibility to manage virtual and physical systems in concert, and that gap must be closed to pave the way for the software-defined data center. Data centers with DCIM recover from outages 85% faster than those without it, according to a 2013 study of data center outages by the Ponemon Institute.

Edge of network gets stronger

After years of consolidation & centralization, IT organizations are turning their attention to the edge of the network to improve interactions with customers and applications. As organizations grow their use of analytics, location-based services & personalized content, edge of network facilities will become critical in achieving competitive advantage. Capitalizing on this opportunity will require standard, intelligent & high availability infrastructure deployed close to users. Just as organizations struggled to keep pace with computing demand in the first decade of this century, enterprises that do not address the networking issues related to the edge will find themselves unable to keep pace with the explosive growth in network traffic.

Security becomes new availability

When it comes to risk mitigation, data center managers have long had a singular focus: prevent downtime. Downtime has not become any less of a risk, but a new threat has emerged in the form of cyber security. When one of the highest profile security breaches in the last 18 months was traced back to the HVAC system, data center managers and IT security specialists took notice. Increasingly, data center and facility managers will have to work with their IT security teams to audit the technology and software of data center equipment to ensure security and evaluate the security practices of the contractors and service providers that have access to that equipment.

Hassell observes what we are seeing is a more holistic, intelligent and integrated approach to data center design and operation, and that is resulting in a new generation of facilities that make more effective use of capital, can respond faster to changing requirements, and that enable simpler management and more accurate forecasting. ■



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Revolutionizing Cold Storage using Advanced Phase Change Material Technology

In an economy which is growing by the day and intends to be in a position wherein it not only helps feed its teeming millions but also grows towards a place wherein it can export its surplus, the key lies in the kind of infrastructure that is provided to support the agricultural back bone of the nation.

- **Consumer trends:** Consumers have shown a paradigm change in consumption patterns hence agricultural produce has to keep pace with it.
- **Storage capacity:** To cater to all the above parameters the single most vital cog in the wheel is the storage

Indian economy is largely an agrarian economy which majorly thrives on factors such as market availability, mobility of the harvest to the nearest market and the storage capacity for postharvest farm produce.



The above representation shows the basic parameters on which the annual agricultural produce largely depends.

- **Land holdings:** In India land holdings have typically been small and changing it might take a lot of effort.
- **Mobility:** Poor roads have hampered the rise in better logistics and control from farm to consumer.

capacity which can be provided right at ground zero & can sharply prevent postharvest losses.

What is a Cold Storage?

A cold storage is essentially a structure that helps maintain and store food grains, fruits and other perishable items at a lower temperature by the application of refrigeration techniques.

Upon harvesting when the perishables are stored in a cold room the drop in temperature helps allay the respiration of the commodity hence keeping it fresh for a longer period of time.

Why do we need cold storages?

India is the largest producer of fruits & second largest producer of vegetables in the world. In spite of sitting pretty on top the per capita availability of fruits and vegetables is quite low because of postharvest losses which account for about 25% to 30% of production (TNAU, 2013). Besides, quality of a sizable quantity of produce also deteriorates by the time it reaches the consumer. Most of the problems relating to the marketing of fruits and vegetables can be traced to their perishability. Perishability is responsible for high marketing costs, market gluts, price fluctuations and other similar problems. At low temperature, perishability is considerably reduced and the shelf life is increased and thus the importance of cold storage or refrigeration.

Challenges facing Cold Chain Sector

The major Challenge that the cold chain sector is facing in the country is the breaking of the cold chain. Experts say that if at any stage of the cold chain the "Chain" breaks or starts leaking the quality of the commodity cannot be assured of. A Major challenge with an energy starved nation like ours is to maintain that chain in spite of power shut downs. Cold chain is a highly energy intensive sector & thus saps out too many resources. A conscious attempt is being made to look up to other available solutions which help cement the cold chain without compromising upon the available natural resources.

The estimated annual production of fruits & vegetables in the country is about 130 million tonnes. This accounts for 18% of our agricultural output (TNAU, 2013). Due to diverse agro climatic conditions and better availability of package of practices, the production is gradually rising. Although, there is a vast scope for increasing the production, the lack of cold storage and cold chain facilities are becoming major bottlenecks in tapping the potential.

What are Phase Change Materials and how do they Work?

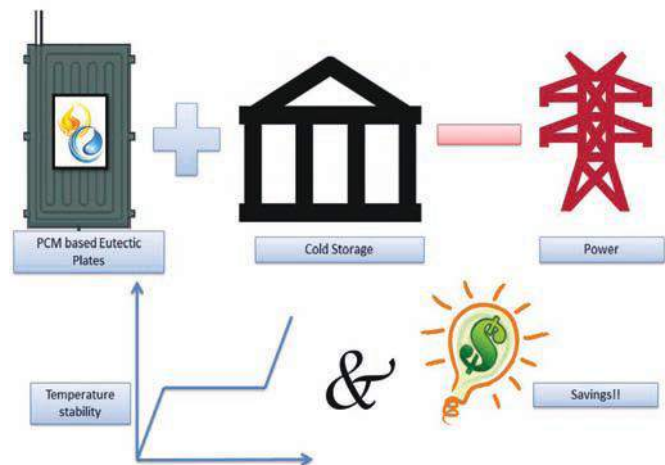
Phase Change Materials or as they are called PCMs can help overcome many a problems being faced by the farmer as well as the bodies trying to organize the production and feasibility of agro-produce. Phase Change Materials work on the simple concept of "Thermal Energy Storage". PCMs have the unique ability to store thermal energy and provide the same at a particular temperature for a large number of hours essentially acting as passive cooling agents.

PCMs can be integrated in a number of ways in a cold storage and can help overcome the most disturbing and

Sagar Chatterji Bachelor in Electronics and Communication Engineering from GautamBuddh Technical University, Lucknow started his career in the Solar PV and Thermal field. He is currently working with Pluss Polymers Pvt Ltd, as an Executive-Business Development for Phase Change Materials focusing on the sectors such as Cold Chain, Retail, Building HVAC, Refrigeration and Renewable energy storage.

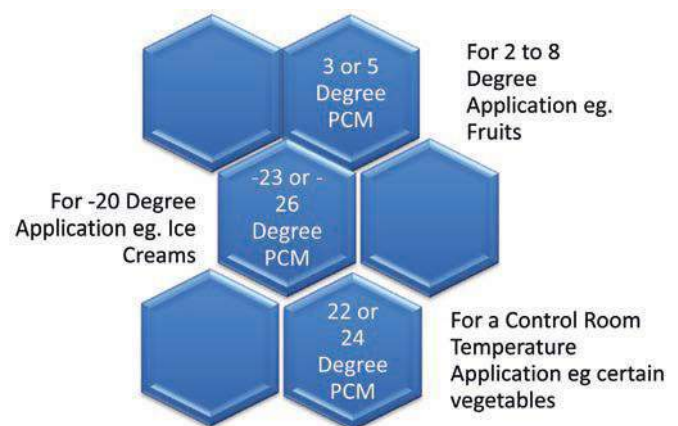


Vishnu Sasidharan Bachelor in Mechanical engineering from Visvesvaraya Technological University, Bangalore and MBA from S P Jain School of Global Management, Dubai/ Singapore. He is currently working with Pluss Polymers Pvt Ltd, heading the Business Development for Phase Change Materials focusing on the sectors such as Cold Chain, Retail, Building HVAC, Refrigeration and Renewable energy storage.



chronic challenge facing the infrastructure of cold storages- "Power Outage". PCMs simply act as "Thermal Batteries" and provide the requisite temperature in spite of the absence of active cooling due to power cuts.

PCMs are engineered to change phase at a particular temperature and hence provide a very precise temperature control which is very vital for any perishable commodity. Different temperature PCMs can provide temperature control over different temperature regions & thus prevent temperature excursion and slowing down the respiration rate in perishables.



Application in solar based Smart Pack Rooms and Micro Cold Storages

Barely 5 percent of India's USD 5 billion cold storage industry is organized (Vohra, 2014). But improving macro-economic conditions have got the country's top logistics players excited and many of them are attempting to become integrated cold chain service providers. This has resulted from the introduction of "Smart Pack Rooms" or "Micro Cold Storages". These are standalone systems located right at the farm and are directly contributing in marginalizing postharvest losses as they are approximately 5MT systems that are providing an immediate place for storage while the farm is being harvested. Solar plus PCM based cold storages working in certain parts of Karnataka and Maharashtra have been able to bring down postharvest losses significantly.



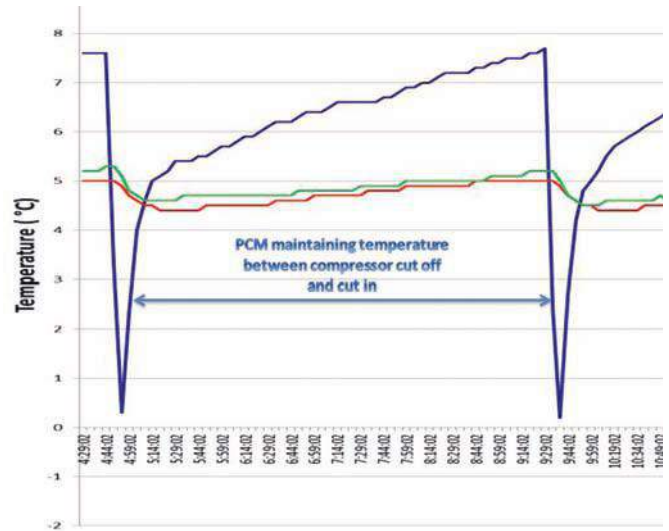
(Solar+PCM based Micro Cold Storage manufactured by EcoFrost a company based out of Pune).

Most importantly such Solar+PCM Micro Cold Storage facilities are "Zero Emission" Cold Storage units that help reduce the energy dependency of the entire cold chain. The functionality of the system can be explained by the below illustration.



These Solar+PCM cold storage have uniquely divided the heat transfer mechanism between two sources. During the day while the sun is available, the solar PV panels help run the cooling unit and simultaneously charge the PCM panels which once charge retain the temperature passively in the absence of the sun at night. The handshake between Solar and PCM is seamless and the carbon throughput is nil. This uniquely innovative solution is help reach out right at the farm level and prevent losses right from its source.

Application to reduce compressor run time



(The above graphical data illustrates the same- it shows how even in the absence of active power the commodity is still being maintained at the required temperature by means of passive cooling.)(Bambardekar, 2014).

Cold Storages work both at the farm level and at the front level. The front level cold stores can immensely benefit from the incorporation of PCMs. PCMs integrated in cold stores help prevent temperature excursion for a lengthier period of time subsequently increasing the cut off time for the compressor. This provides two basic benefits to the operator of the cold store-

- A longer shelf life of the compressor.
- Energy savings which in turn reflect as monetary savings.

The immense benefits of PCMs can be traced to all parts of the Cold Chain right from farm to your fridge.

Cold Storages have a vital role to play in reducing the perishability of farm produce rendering the trickle down to the last consumer, ensuring reduced wastage. The inherent problems in the system can be alternately taken care of by innovative methods such as introduction of new age materials such as PCMs which can help Cold Storages work better and face the short falls with high acumen.

The availability of stand along zero emission systems add more value to the whole chain making turning it from energy intensive to energy inclusive. The way forward is to look up to such solutions which can offer simplistic integration with the existing system and seamlessly synergize the working of the cold chain.



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Reflective Insulation

The radiant heat is invisible and has no temperature, just energy. When this energy strikes another surface, it is absorbed & 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 & 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 fibers 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 fiberglass, foam and cellulose have "E" values in excess of 0.70.

Reflective insulation 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. In all cases, the reflective material must be adjacent to an air space. Aluminum, 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 Reflective Insulation System (RIS)

A reflective insulation system is typically formed by layers of aluminum 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 aluminum and enclosed air space (INSUreflector), is 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 as follows

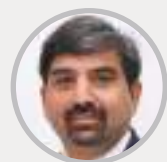
- Reflective insulation has very low emittance values "E-values" (typically 0.03 compared to 0.90 for most insulation) thus significantly reduces heat transfer by radiation
- A reflective insulation does not have significant mass to absorb and retain heat
- Reflective insulation has lower moisture transfer and absorption rates, in most cases
- Reflective insulation traps air with layers of aluminum & Air bubble film plastic as opposed to mass insulation which uses fibers of glass, particles of foam, or ground up paper
- Reflective insulation does not irritate the skin, eyes, or throat and contain no substances which will out-gas
- 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-

- Ducting insulation in hospitals, shopping malls, airports, PEBs, IT/BPO etc.
- Pipe insulation for split AC tubings, chiller piping, drain pipes, chilled water lines etc.
- Floor insulation in server rooms, data centres, medical and diagnostic centres, and control rooms for petrochemicals.
- Underdeck insulation in PEBs, textile units, malls, airports
- 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 aluminum foil on one or both sides. The bright surface of the aluminum 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, tri dimensional chemically is ideal environment friendly insulation material, with a perfect solution for all your insulation needs for ducts, roofs, pipes, vessels, etc. ■

Atul Khanna, General Manager -
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Postharvest Handling of Horticultural Produce

All fresh horticultural products like fruits and vegetables are living organisms carrying on many metabolic processes that are vital to the support life. So, they must remain healthy and alive till processed or consumed.

The energy needed to maintain life processes comes from respiration which converts accumulated food reserve (carbohydrates) into carbon dioxide, water vapor and release heat. Amount of heat released varies with the type of product, variety, maturity, stage of ripeness, injuries, temperature and other stress related factors. This heat must be considered in any temperature management program. Hence maintaining longer shelf life as well as quality of fresh produce requires keeping check on the temperature of the horticultural produce. Appearance (visual), texture (feel), flavor (taste and smell), nutritive value and safety are issues that determine the market price of the horticultural produce. Producers are concerned with good appearance (size, shape and color) with few visual defects while receiver and market distributor are

interested in firmness and long storage life. Consumer considers good quality fruits and vegetables to be those that look good, firm and offer good flavor and nutritive value. Although consumers buy on the basis of appearance and feel, their satisfaction and repeat purchases are dependent on good edible quality. Hence after harvesting, the value of fruits and vegetables is added in successive stages up to the point when someone eats them. The aim of postharvest management is to maximise this added value. This ultimately should benefit the whole community, whether through increased export earnings or extending the availability of fresh produce through the year. Conversely losses hurt everyone. CIPHET has estimated that from 5 to 18% of fruit and vegetables leaving the farm gate is never consumed, but has to be thrown away. Obviously, disease and over supply



Dr Mahesh Kumar, Professor and Member, State level Committee for Establishment and Up gradation of Cold Stores of Punjab, Punjab Horticultural Post- harvest Technology Center, Punjab Agricultural University Ludhiana, Punjab. He has expertise in post harvest handling of Fruits & Vegetables.



Dr W S Dhillon, Director, Punjab Horticultural Post- harvest Technology Center, PAU, Ludhiana, Punjab, developed\ recommended 11 varieties\rootstock of different fruit crops. He has received many awards, recognitions and appreciations, and Life Time Achievements in Sports. He is Founder Secretary of Horticultural Science Society; Executive Councilor of HSI etc.



Dr B V C Mahajan, Professor and Chairman, State level Committee for Establishment and Up gradation of Cold Stores of Punjab, Punjab Horticultural Post- harvest Technology Center Punjab Agricultural University Ludhiana, Punjab.



contribute to this, but there are many other reasons for the losses. Postharvest management can influence all them, with the two most important areas being temperature management & packaging.

Impact of Postharvest Losses

Postharvest disorders or losses in quality have economic impacts vastly greater than the actual losses caused by frequency and intensity of their occurrence. For example there are direct financial losses incurred by the grower from batches of fruit expressing the disorder. Direct losses can also cause financial losses for postharvest operators and marketers. If the problem arises more than once then there is increased quality compliance costs that arise from systems being put in place to monitor all lines and isolate problem batches. An intermittent and unpredictable disorder occurring in the market is a real problem, as it will increasingly undermine trade confidence in the product causing downward price pressure. Another point to remember is that the loss of value of a downgraded product is likely to be substantially greater for highly differentiated branded products which sell at a premium in the market. All the hard work that has gone into promoting

and raising the profile of a branded product can be quickly eroded if there are postharvest quality problems with some lines of that product.

Nature of Postharvest Management

Horticultural produce is alive and has to stay alive long after harvest. Like other living material it uses up oxygen and gives out carbon dioxide. It also means that it has to receive intensive care. For a plant, harvesting is a kind of amputation. In the field it is connected to roots that give it water and leaves which provide it with the food energy it needs to live. Once harvested and separated from its sources of water and nourishment it must inevitably die. The role of postharvest handling is to delay that death for as long as possible. Horticultural managers must possess many skills to succeed in this. They need a keen appreciation of horticultural diversity. For example, spinach & apples, bananas and potatoes each have their own requirements. The optimum postharvest management of horticultural products is not the same for all products. Growers, wholesalers, exporters and retailers must all be aware of the specific needs of a product if the postharvest shelf life and quality is to be maximised

Understanding Product Maturity

The stage of development at which a product is regarded as mature depends on its final use. Fruit and vegetables are eaten at all stages of development. We eat sprouted seeds, vegetative leaves and flowers, whole fruit as well as seeds and nuts. There are no general rules when it comes to defining horticultural maturity. A lot of research has been done to establish maturity parameters for a whole range of specific horticultural products. Maturity must be defined for each product in some cases for each variety of a particular product. The use of maturity standards provides consumers with a minimum level of quality assurance. Another reason for establishing maturity standards is that most horticultural products are harvested by hand. A simple colour guide and size can help pickers harvest produce at the correct stage of development

Harvest Handling

The care taken during harvesting is repaid later, because fewer bruises and other injuries mean less disease and enhanced value. Good managers train their pickers so that they select the product at the correct stage of maturity

with adequate care. It is worthwhile reducing the amount of hard physical work required in picking fruit and vegetables as far as possible. In recent years conveyors have been introduced for vegetable crops such as lettuce or celery and "cherry pickers" for tree crops. Such as increase the comfort and speed of harvesting and help the pickers to devote more energy to the care of the product.

Pre-Cooling

The harvested produce has to be transported to the packing shed without delay. In the field the heat of the sun and the respiration of the produce combine to heat up the produce, especially in the centre of field bins. This accumulation of "field heat" reduces the postharvest life of the product and has to be removed quickly. Even under the best conditions, when the harvest is in the cool of the morning and the bins are placed in the shade, heat production can only be controlled by active refrigeration. Strawberries for example, respire nearly eight times faster at a field temperature of 25°C as they do in a storage temperature of 0°C. In other words, one day left warm in the field sacrifices as much as eight days of storage life.

Precooling requires a greater refrigeration capacity than the cool storage and is often best done as a separate step. Hydro-cooling with cold water drenches, forced air cooling through stacks that ensure proper air distribution and packing with ice are the systems most commonly used, with the choice depending on the individual requirements of the commodity

Refrigeration

Refrigeration is the most important tool for extending the life of fruit and vegetables. Whatever else is available to give additional storage life, good temperature control is critical to all of them.

In a typical cool store. Fans circulate air over the refrigerator coils. To maintain a storage temperature of 0°C the temperature of the coils will have to be appreciably below 0°C. Moisture is therefore removed from the air and this accumulates as ice on the coils. The

lower the average temperature of the cooling coils, the more moisture will be removed. The drier and cooler air then circulates around the room where it warms and picks up moisture. Sources of heat are through the walls, air exchange with the outside air and the heat produced in the room, for instance by the respiration of the produce and the fans themselves.

Unless a plastic film or some other vapour barrier protects the product, water evaporates from it. Another important source of moisture is outside air exchanging with that in the room. The more moisture that freezes on the refrigerator coils, the greater the frequency of defrost cycles and these make good temperature management control more difficult to attain.

It is also important to maintain a uniform temperature in all parts of the cool room. Only if this is done is it possible to use the lowest and most effective storage temperatures. If one part of the cool room is warmer than another then the out turn of the produce will be mixed as produce stored in the warm area may ripen faster. It is important that the core temperatures of the packages in the room be checked at several places as well as at the floor and ceiling levels. A good deal of skill is required to maintain good air circulation when the arrangement of bulk bins or pallet loads is being continually changed with produce coming in and out of the store. An even distribution of air produces a room with a consistent temperature, but if the flow of cooled air is "short circuited" back to the coiling coils, the areas starved of circulation will become warmer.

Quality Control

Most consumers have been disappointed with the quality of fresh produce they have purchased at one time or another. They may say that tomatoes no longer taste like they used to and plums are tasteless at times. The loss of quality is often the price we pay for being able to buy these products out of season. Fruit and vegetables that are to be stored or transported over long distances may

have to be picked in an immature state so that the fruit are firm and store or travel well. In recent years, much work has been done to improve the quality of fruit and vegetables. New varieties have been introduced which gives consumers a wider choice and some, such as new varieties of nectarine have improved flavour. Many growers also have accreditation for product quality and handling and so this improves the consistency of quality of products on the market. However, despite the best efforts to handle fresh produce in the optimum way there will always be compromises to be made which affect the final quality of the product. Much of the fresh produce we eat must travel many kilometres to reach the central or wholesale market or distribution centre and from there it travels to local or distant retail outlets. Postharvest handling should go as far as it can to maintain the freshness and quality of a product. Good handling will ensure that the final consumers are satisfied and so will return again to buy that product

Storage

In modern times, the storage of perishables has become more sophisticated because of the demand for a wide range of fresh fruits and vegetables at all the times of the year and because of need to spread peaks of production over longer periods to maximize profit and reduce waste. Storage can also be used to extend the processing season of some commodities and to provide planting materials when needed. But in our conditions, storage of fruits and vegetables is practiced to avoid the low prices during the glut season in anticipation that prices will increase during the lean period or off-season. Certain crops like potatoes and apples can be stored for long period whereas for the crops like tomatoes and peaches, the storage period is very short. However, for both long-term as well as short-term storage, high level of technical know-how about the crop is necessary for successful storage. There are a few important factors, which need to be taken into account before storage of the produce.

- Suitability of crops for storage
- Knowledge of appropriate storage conditions
- Compatibility with other crops for storage.
- Induction of leaf disorders (russet spotting in lettuce, death of leafy greens)
- Isocoumarin formation (bitter taste in carrots).

Product	Temp. (°C)	RH (%)	Approx. Storage Life
Fruits			
Apple	-1-0	90-95	4-6 months
Pathar Nakh (Pear)	1	90-95	2 months
Litchi	1.5	90-95	2 weeks
Grapes	0	90-95	20-40 days*
Peaches	0	90-95	2-3 weeks
Kinnow	4-6	90-95	1.5-2 months
Mango	13	85-90	10-12 days
Guava	6-8	90	2 weeks
Ber	7-8	90-95	2 weeks
Product	Temp. (°C)	RH (%)	Approx. Storage Life
Cauliflower	0	95-98	3-4 weeks
Cabbage	0	95-98	1-4 months
Peas	0	95-98	1-2 weeks
Carrot	0	95-98	3-5 months
Potato (seed)	1-2	90-95	4-8 months
Potato	4-10	90-95	3-5 months**
Bhindi (Okra)	7-10	90-95	7-10 days
Capsicum	7-10	90-95	10 days
Onion	0	65-70	3-8 months
Bitter guard	12-13	85-90	10 days
Tomato (Pink)	10-13	85-90	7-10 days
Tomato (Ripe)	7-10	85-90	3-5 days
Tomato (Mature green)	13-18	85-90	2-3 weeks
Appropriate storage conditions for Fruits and vegetables			

Ethylene in the storage environment

Ethylene causes a wide range of damage symptoms in sensitive commodities. Avoid handling or storing ethylene sensitive commodities with ethylene producing ones.

Undesirable effects of ethylene

- Accelerated ripening (in climateric fruits)
- Loss of green colour (snap beans, cucumber, leafy greens)

The ripening of mature fruit of mango, banana, papaya, chiku etc. is major postharvest operation undertaken by the distribution markets. In general, ready-to-eat ripened fruits are delivered, loaded loose, in railway wagons, trucks, tractor-trolleys, bullock carts etc. to the market. The ripening is either done by wholesalers or the produce is sold to retailers to ripen and sell. These days, mature produce is packed in wooden/CFB boxes, after grading and delivered to the market. Some traders give the ripening treatment by dipping in ethephon solution or use calcium carbide salt which is banned under PFA, wrapped in used news paper pieces in produce during loading and the produce partially ripens by the time it reaches the market. However, if the vehicle gets delayed due to breakdown/held up in traffic jams, the produce may rot before reaching the destination. If the transportation is done in reefer vans (temp. and RH control), transit ripening is feasible. The institutional and bigger distributors of banana and mango may try this to cut down costs and time for delivery, but this requires dedicated vehicles and trained manpower.

We produce 17% of the global total of vegetables and 14% in the case of fruits. India is the second largest producer of mango, banana, papaya, sapota, pomegranate and aonla. About 40% of the world's mangoes and 30% of the world's bananas and papayas are produced in India. In terms of productivity of grapes, India ranks first in the world. While production of horticultural crops has been increasing since Independence, tremendous growth in area, production and productivity has been in evidence ever since the Eighth Plan (1992-97). Fruits and vegetables together constitute about 92% of the total horticultural production in the country. India has a wide range of horticultural and floricultural produce, namely fruits, vegetables, tropical tuber crops, ornamental crops, medicinal and

aromatic plants, spices, cut flowers, ornamental plants and plantation crops like coconut, tea, coffee, cashew, cocoa, honey and rubber. Government placed major emphasis on horticulture since the mid-1980s to provide farmers with a means to diversify their activities and make farming more profitable. Increase efficiency and utilization of natural resources, namely land, soil quality, water and the general environment and to create skilled employment for rural people, especially women. The past efforts have been rewarding and India is now the largest producer of coconut, areca nut, cashew, ginger, turmeric, black pepper and the second largest producer of fruits, vegetables and tea. Among new crops are kiwi, olive, gherkins, kinnow and oil palm which have all been successfully introduced for commercial cultivation in the country.

Potential of fruits and vegetables in Punjab: Horticulture has been identified as one of the economically viable and sustainable alternatives to wheat-paddy rotation in Punjab, which not only promotes efficiency in land use, but also creates opportunities for employment particularly for youth and woman in rural areas.

Fruits and vegetable crops are being grown in the State in about 2.80 lakh which is about 7% of the net sown area. The annual production of these crops is 65.52 lakh tones which is about 22% of the total food grain production in Punjab

Crops	Area ('000ha) Production	Crops Area ('000ha) Production ('000 MTS)
Fruits	76.59	1541.24
Vegetables	2.04	4011.03

The Punjab State leads in citrus production among the fruit crops with the highest production of Kinnow. This crop occupies an area of 47.1 thousand ha contributing 67% of the total fruits produced in Punjab. Likewise, potato is the major leading vegetable crop of Punjab having an area of 87.2 thousand ha with 55% of the vegetable production.

Apart from Kinnow, other fruit crops like guava, mango, pear & peach has significant area in the state. Similarly,

other than potatoes, pea, cucurbits, chillies, pepper, onion, cauliflower, tomato, brinjal and carrot etc. are major vegetables grown in the State. Turmeric, ginger and garlic production is also gradually rising- up, due to the availability of adaptive and agro-climatic condition of the State. Similarly, onion is another important crop for domestic use and export. This can be promoted as an alternative crop in the state where assured irrigation facilities are available. However, it is a labour intensive crop that demands mechanization for successful cultivation. Pea is the third important vegetable crop and consumed as fresh and frozen. It is available in the state from November to March.

Common Processing Techniques for Horticultural Produce

Packaging of fresh and Processed Products

It is one of the most important unit operations in the agro-processing industry. In modern times, packaging has been identified as an integral part of processing in the food industry as it protects products from the adverse effects of the environment. Packaging is helpful for the safe delivery of the contents from the centers of production to the points of consumption. The primary objectives of food packaging are to provide protection from spoilage, ease in distribution, display and handling, communication between the manufacturer & customer, convenience, avoidance of loss, brand confidence, printing and machine suitability (Fig. 1). The packaging materials vary for different products depending upon the product and its storage requirements. Food packaging employs a variety of materials. They are

- Rigid metal containers such as cans and drums,
- Flexible metals as in aluminum and tin foils,
- Glass as in jars and bottles,
- Rigid & semi-rigid plastics as squeeze bottles,
- Flexible plastics as in pouches and wrappers,
- Rigid card-board, paper and wood as in boxes,



Fig. 1: Packaging of fresh horticultural produce with cling and shrink wrap films

- Flexible papers as in boxes, bags and laminates and
- Multiplier laminates which may combine paper, plastic and foil.

Packaging of foods has become very complex, and considerable research and development efforts have been made to provide better and cheaper packaging material and packaging methods.

Controlled/Modified Atmosphere (CA/MA) Packaging: These are upcoming techniques for the packaging of fresh and perishable produce. Modified atmosphere (MA) essentially means deviation from the normal atmospheric gas composition of a regular atmosphere. Therefore, MA or CA essentially means removal or addition of gases surrounding the commodity either from inside of a package or the storage chamber resulting in an altered atmospheric composition as compared to regular atmosphere (Fig. 2). Usually modification of atmosphere for packaging of fresh horticultural commodities involves reduction of O₂ and elevation of CO₂ concentrations. CA/MA storage helps in retardation of ripening, senescence and physiological as well as microbial changes. It thus helps in reduction of quantitative and qualitative reduction in post-harvest losses of horticultural commodities.

Freezing

Freezing is the most harmless method of preservation and is an excellent way to preserve fresh fruits and vegetables at commercial and domestic level. It is the speedy removal of heat



Fig. 2: Modified atmosphere packaging of brinjal and frozen pea available in the market

from horticultural crops. Freezing does not sterilize food. The extreme cold simply retards growth of microorganisms and slows down changes that affect quality or cause spoilage in food. Most foods retain their natural colour, flavour and texture better than when other methods of food preservation are used. Freezing may preserve foods for long periods of time provided the quality of the food is good to begin with and the temperature of storage (-18°C) is far below the actual freezing temperature (-0.5°C) of food (Fig. 2).

Drying

Of all food preservation methods, drying foods has received the most widespread acceptability. It is one of the oldest methods of food preservation and techniques have been passed from one generation to another based on experience. Today, the variety of dried foods are available in the market and are quite popular among the consumer especially the spices and herbs. Dried tea leaves, fenugreek (methi), Curry tree leaves (sweet neem), mango pulp



Fig. 3: View of solar drier fabricated for drying of fruits and Vegetables

(amchur), dried pomegranate kernels (anardana), amla powder, triphlla, grapes etc. are among the most commonly used products in our kitchen. Most of food spoiling agents (micro-organisms) including biochemical reactions needs water to act. When foods are sufficiently dehydrated (dried), microorganisms cannot grow and foods will not spoil. Exposure to high temperature heated air during drying operation and blanching vegetables before drying (to destroy enzymes) can result in some loss of water soluble vitamin C, B-complex. Foods can be dehydrated by various means: the sun, a solar dryer (Fig. 3), an electric



Fig. 4: Drying of (Fenugreek) Kasurimethi in tray dryer

dehydrator (Fig. 4) or a microwave oven (forherbs only). Unless sun drying is possible, the energy cost of dehydrating foods will add to the cost of processing. Solar drying is a process of drying foods by harnessing the heat energy of the sun in a special dehydrator that not only increase the temperature but also, improves the air flow. So it is a modification of sun drying in which the sun's rays are collected inside a specially designed unit with adequate ventilation for removal of moist air. The temperature in the unit is usually 15 to 20°C higher than in open sunlight, which results in a shorter drying time. ■

Energy efficient water management pumping solutions at Assam Water Conference 2015

Grundfos Pumps India Pvt Ltd (Grundfos India), one of the leading pump manufacturers in the country, showcased its optimized flood control and energy efficient water management pumping solutions at the Assam Water Conference 2015. This conference held in Guwahati during February proved to be a forum for knowledge sharing and pooling of experience on the entire range of subjects dealing with the Water Resources Management. With the focus on efficient management during flooding, the theme of the conference was 'Management of Water Related Disasters - Urban and Rural.' Grundfos India showcased its Scada and PLC based solutions for flood control along with its innovative water management pumping solutions such as its solar submersible range of pumps SQFlex & SPFlex and solar surface range of pumps,



CR Flex at the conference. The company also featured its Demand Driven Distribution (DDD) system, which is aimed at reducing costs and limit water losses in a 24X7 water distribution system by effective pressure control. The Grundfos controller works with all pump types, offering substantial economic benefits from energy savings and reduced leakage losses. With its innovative and reliable flood control solutions, Grundfos goes further than most to prevent flooding in a financially and environmentally sustainable way, addressing the key issues of safeguarding people, crops, business, cities and regional infrastructure. As part of their energy-efficient flood control solutions, the company supplies a complete range of products optimized for high efficiency

and low maintenance costs. Grundfos' solar submersible range of pumps, SQFlex comes with 10 different sizes which can be used at different locations ensuring excellent high, medium and low water flows at any conditions. These pumps are also fitted with a high energy motor for AC or DC Voltage which makes pump sizing and selection extremely easy. SPFlex range of pumps ensures flexible and sustainable water supply using clean and green energy. These pumps are available from 2.2 kW and is widely used in water supply applications in irrigation, fish farming and livestock. While the company's solar surface range of pumps, CRFlex offers the most sustainable, reliable and cost effective alternative to irregular water supply in remote locations or for any specific applications anywhere. Grundfos India has installed over 9000 solar pumps across the country. ■



Green Heating with Free Chilling

The last century has been an era of rapid industrial growth and economic development. This growth was accompanied by an ever increasing demand for Energy, derived essentially by burning fossil fuels. The after effects of this massive energy consumption have now begun to show their face. Pollution, Climate Change, Global warming & CO₂ emissions have now become common words affecting every household.

In order to preserve these fossil resources for the future and to reduce environment destruction, energy conservation has become the need of the hour. Individuals and organizations may want to conserve energy in order to reduce energy costs, increase efficiency & thus maximize profit. Energy conservation or reduction in energy consumption can be achieved either through efficient energy use or by reducing consumption of energy.

In most of the industries substantial amount of energy is consumed in generating hot water and refrigeration effect. If these process operations of heating and chilling are made more efficient, then significant amount of energy consumption can be reduced. Thermax Ltd. with the aim of providing energy efficient & environment friendly solution for such dual applications has come up with a product which simultaneously provides chilling and heating using its Vapour absorption technology.

Before getting acquainted to the product, Let us first have a look at the conventional industrial practices for generating hot water and chilling.

Conventional Systems

In many industries and commercial complexes, there is need for chilling and heating. With more and more new projects

coming up, growth in real estate market and process industry, requirement for chilling and heating is showing an upward trend. Most of this heating requirement is for Hot water at temperatures below 90°C and Chilling demand is mainly for process cooling or air conditioning.

Traditionally for generating this 90°C hot water, hot water generators have been used which are either fossil fuel fired (like gas, oil, etc) or Steam fired. (Steam being generated again using fossil fuel fired boiler). Thus for producing 90°C hot water, flue gases at 1000°C produced by combustion of fuels are used. Thus high grade heat is used to produce low temperature hot water. These systems require close to 115 kW of fuel energy input for producing hot water of 100 kW heat content. 15 kW of heat is lost due to energy losses in combustion. Fig. 1 indicates the conventional Heating system.

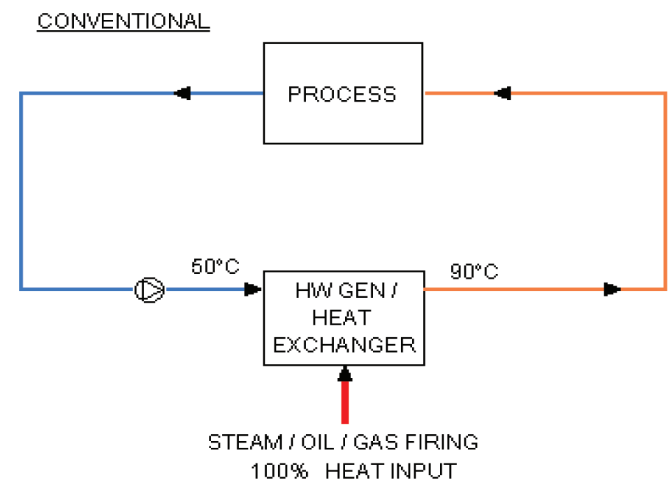


Fig. 1: Conventional heating System



P Babu Mechanical Engineer from Anna University working with Thermax Ltd, Pune, is heading innovation department for absorption chillers and heat pumps. He introduced world's first lithium bromide double effect chiller working at 0°C and new products for Thermax viz Absorption Heat Pumps, Trigeration and direct exhaust driven chiller. He received three national innovation awards for product innovations in absorption chillers. He has applied 10 patents including 4 international patents in the field of absorption chillers. One of his paper was presented on ASME International Engineering Congress, Chicago in 2006



Refrigeration or Chilling means extracting heat from a low temperature source and rejecting it to a high temperature sink, with the help of an external driving energy force. Refrigeration effect can be achieved either using conventional electrical chillers powered by

electrical energy or by using Vapour absorption machines driven by heat source like steam, fuel firing, etc. Electrical chillers consume 100 kW electrical energy for generating 470 kW of chilling and Vapour Absorption Machines consume 100 kW of low grade heat energy for producing 140 kW of chilling. Further, these chillers require cooling tower for heat rejection. Since cooling towers operate on the principle of evaporative cooling there are water losses accompanied. Hence good quality (softened) water is required for make-up. Fig. 2 indicates the conventional chilling system.

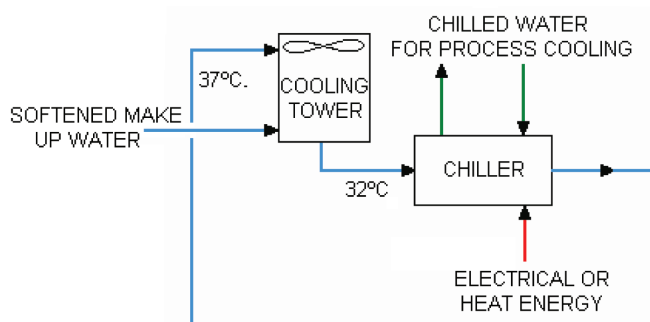


Fig. 2: Conventional Chilling System

New Energy Efficient System (Chiller Heat Pump)

There could be applications in industry where both chilled water and hot water are required. As discussed before to cater to this requirement of simultaneous heating and chilling, traditionally two separate systems have been used, one is hot water generator and the other is Electrical or vapour absorption chiller for refrigeration. Incorporating two separate systems implies higher capital investment in balance of plant, maintenance, etc.

With the aim of providing a single point solution for such dual purpose application a product has been developed which provides both chilling & heating (hot water generation) in a Single vapour absorption machine. Using Vapour absorption machines has its own advantages of low operating costs as they use low-grade waste heat. Vapor compression chillers, in contrast, must be electrical power driven. Furthermore, as absorption chillers use water as refrigerant, they are non ozone depleting and hence are the natural choice for green energy planners. Fig. 3 indicates a schematic diagram of this new product.

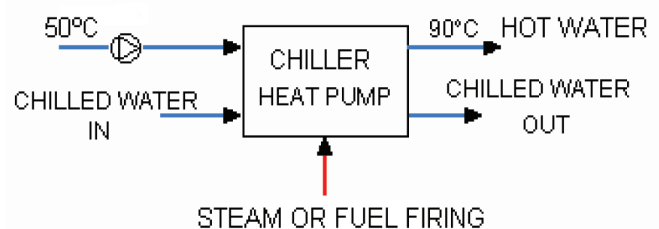


Fig. 3: Simultaneous Chilling & Heating System

The technical design of this product has been a challenge as low temperature chilling using high temperature heat rejection has been made possible in this breakthrough invention. This is the first of a kind product and has been filed for international patent application.

Benefits of Installing a Chiller Heat Pump

- The benefits of this product can be outlined as -
- Lower fuel consumption for hot water generation as compared to hot water generators
 - Lower electrical consumption for chilling as compared to compression chillers
 - No water losses, Softening plant, Cooling tower fan power as cooling tower has become redundant
 - Reduction in CO₂ emissions (carbon credits) due to lower fuel consumption
 - Reduction in the scope of utilities to be handled daily as single product is used in place of two systems, thus reducing operating costs.

The benefits or savings incurred by using this product are also indicated in Table 1 wherein the new product – Chiller Heat pump has been compared with a conventional system for generating hot water and chilled water comprising of Compression chiller and hot water generator.

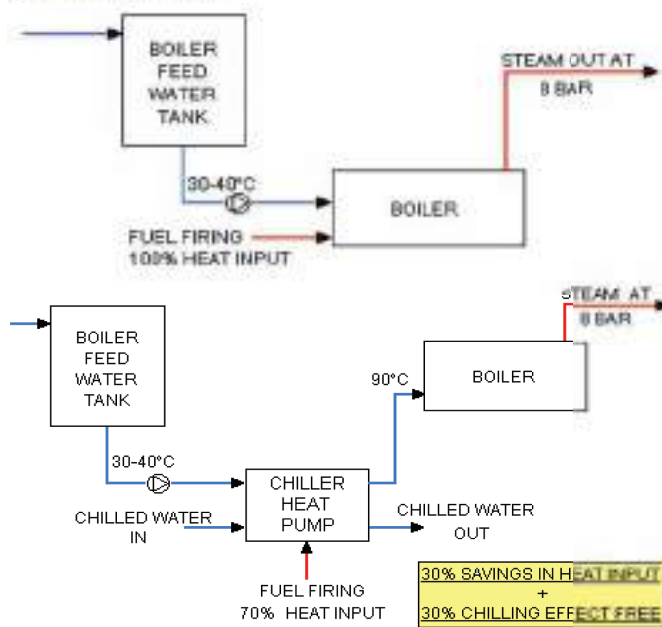
Sr. No.	Description	UOM	Compression Chiller + HW Generator	Chiller Heat Pump
1	Chilling Capacity	TR	100	100
2	Heating Capacity	kW	1055	1055
3	Energy Source for Chilling		Electricity	Gas
4	Energy Source for HW Generation		Gas	Gas
5	Energy Consumption	Nm ³ /hr	108	72
6	Power requirement			
	Chilled water pump	kW	7.5	7.5
	Cooling water pump	kW	15	-
	Hot water pump	kW	7.5	7.5
	Cooling tower fan	kW	5.5	-
	Hot water Generator power	kW	4	-
	Chiller power	kW	75	27
7	Total Power	kW	115	42
8	Water consumption (i.e. Evaporation loss)	m ³ /hr	0.7	-
9	No of hrs of operation	hrs/yr	4000	
10	Amount of fuel saved	Nm ³ /yr	144,000	
11	Amount of power saved	kW/yr	290,000	
12	Water saved	m ³ /yr	2680	
13	Reduction in CO ₂ emissions	kg/yr	316800	
14	Carbon Credits	CR	317	

Table 1: Comparison between Conventional system and Chiller Heat pump for generating Chilling and heating simultaneously

Avenues for Chiller Heat Pump

- Feed water heater for boiler:** Conventionally in a boiler, water needs to be heated from ambient temperature to its saturated steam pressure and temperature. In a Furnace oil fired boiler, the water needs to be heated up to 90°C

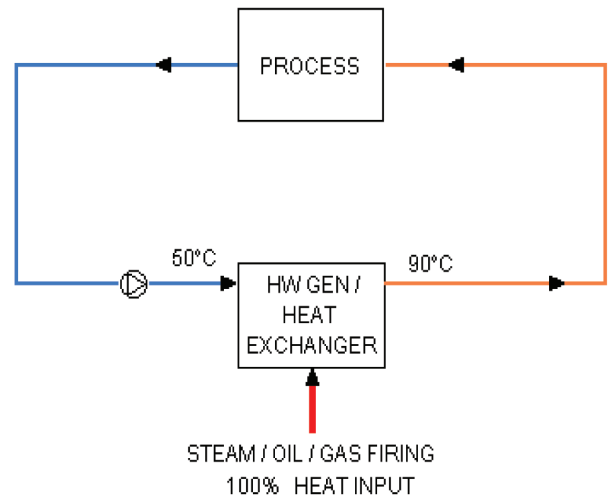
CONVENTIONAL CYCLE



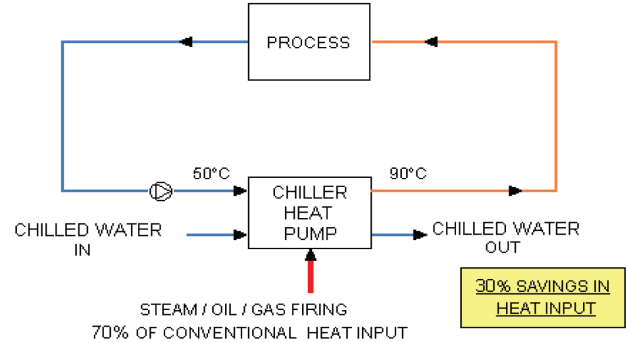
temperature before it enters the boiler. Such heating is required to drive out the oxygen from the water to avoid oxygen attack in the boiler tubes. In a shell type boiler, normally this heating is done by means of steam sparging in the feed water tank. By using Chiller Heat pump, savings of up to 30% in fuel firing can be achieved as 30% heat is utilized from Chilled water and at the same time free Chilling is generated which can be used for air conditioning of factory premises.

- Process industries:** In Process industries like Textile, Paper, Hot water at ~90°C is required for process heating. 30% heat from Chilled water and 70% from external heat source can be pumped to generate 90°C hot water in Vapour absorption Chiller Heat Pump. Here again Chilling will be generated as a byproduct & can be used for process cooling.

CONVENTIONAL

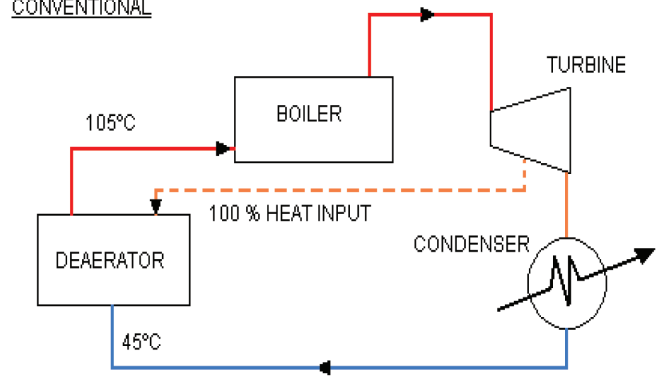


THROUGH HEAT PUMP

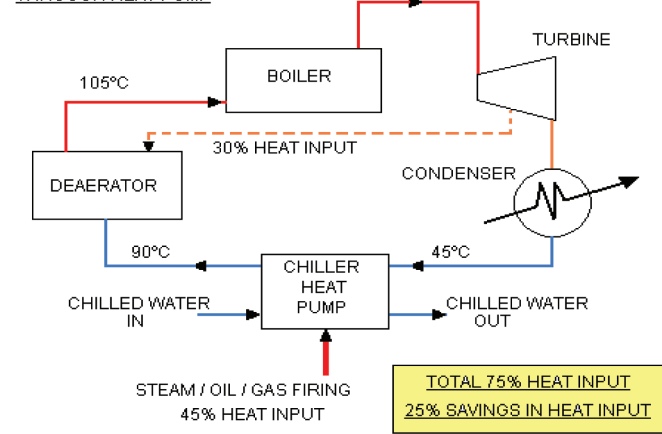


- Turbine condensate Pre heating:** In the water tube boiler the heating is done in the deaerator where the water is heated by steam up to 105°C. By using a Chiller heat pump the steam consumption for heating can be reduced up to 30% as indicated in the diagram. Use of Chiller Heat pump for turbine condensate pre-heating is limited to power plants of 10MW size which use only one LP heater operating at higher steam pressures.
- In automobile industry:** In these industries hot water at 90°C is required in painting booths. They also have cooling towers, exhaust gases are generated in Ovens, furnaces, DG Sets, etc. Shown herein is the integration of all waste heat

CONVENTIONAL

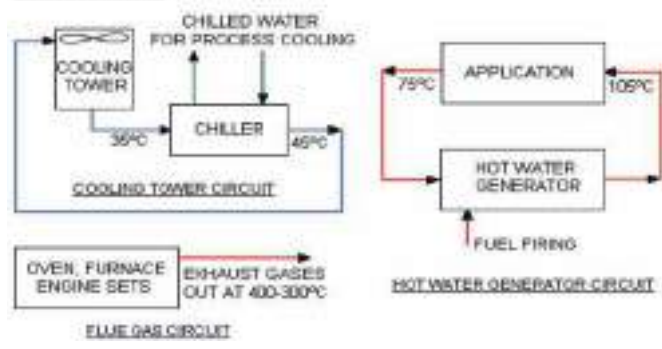


THROUGH HEAT PUMP

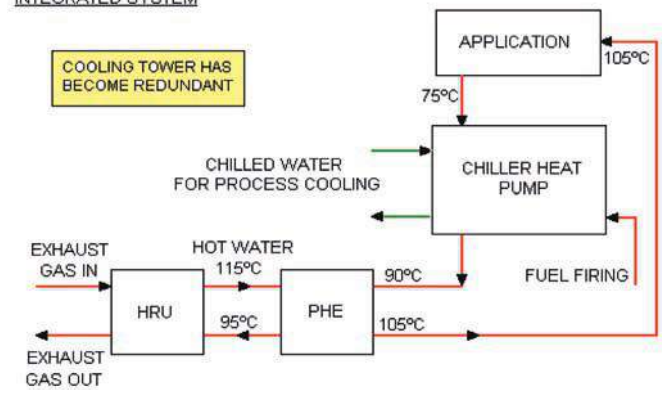


resources using a Chiller heat pump to generate hot water & Chilling for Air conditioning or process applications. Thus by this system integration, Heat input savings are in the form of reduced fuel firing, utilization of exhaust gas heat content and reduction in cooling tower heat duty.

EXISTING SYSTEM

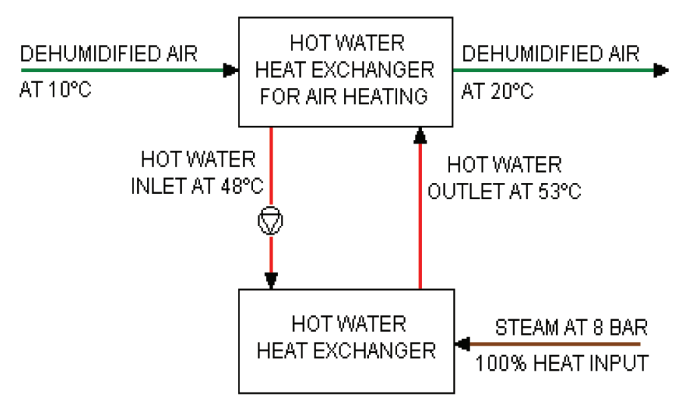


INTEGRATED SYSTEM

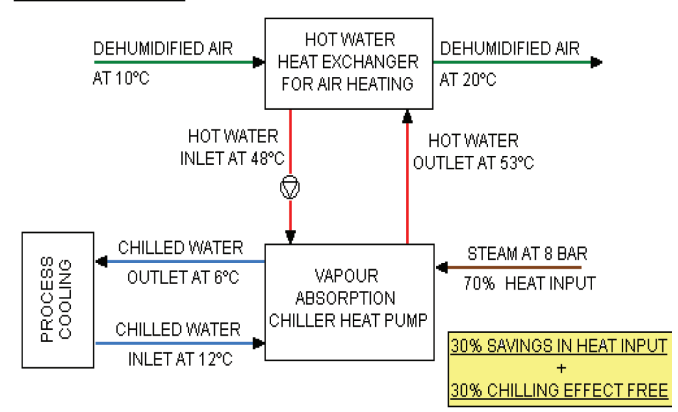


- **Reheating in Pharmaceutical Industry:** In Industries like pharmaceuticals maintaining low humidity is very important. Many times the re-heater has to be used after the cooling coil for this purpose. The re-heater can be an electric heater or steam/ hot water coil. The Chiller heat pump can be placed as a re-heater and again 30% of energy required for re-heating can be drawn free of cost from Chilled water.

CONVENTIONAL CYCLE



THROUGH HEAT PUMP



- **Calorifier in Hotels:** In hotels, calorifiers are used for generating hot water mostly using steam. Here again Chiller Heat pump can be used to generate hot water and chilling obtained free can be used for comfort cooling.
- **Milk dairy:** In dairies, Pasteurizers require hot water in the range of 78-80°C. Milk dairies also require chilled water for preserving milk, extraction of heat from pasteurized milk before transportation. Here again Chiller Heat pump can be put to use effectively.
- **Food Industry:** In Ready-to-eat dishes industry like pasta, etc the raw material (flour) is combined with hot water at ~ 70°C before being taken up for further processing. Here again, chiller heat pump can be used to generate hot water and chilled water which can find process applications.
- **Other Applications:** There could be many other applications in the industry where hot water from 40–80°C & chilling is required. Some of the applications could be hot water required for Latex industry, Breweries, Poultry/Hatcheries for washing, humidity control, Plywood industry, tiles, etc. ■



New Innovations in Container Refrigeration

In Sept-Oct 2009 issue of Cooling India, we carried an article titled New Developments in Reefer Container Technology. This article is to be seen as a continuation of the above article and it provides an overview of the changes which have occurred in Reefer Container Technology over these five years.

CO₂ making a comeback as refrigerant. Necessity is the Poor Dad of Invention. Competition is the Rich Dad of Innovation. In their continuous pursuit for environment friendly refrigerants and with the global mounting pressure, Container Refrigeration machinery manufacturers have been sweating and they have come out with some innovative improvements.

There has been a strong movement to switch over to CO₂ (R-744) as refrigerant. In December 2011, Carrier unveiled its first CO₂ based Container Unit under the name NaturaLINE, which has been validated by UL Environment as having a 95% recyclability rate. CO₂ has GWP of 1 compared to HCFCs and HFCs which have relatively much higher GWP values. Other manufacturers of Container Refrigeration machinery have also followed suit with models of similar features.

UL Environment which is a wholly owned subsidiary of UL (Underwriters Laboratories) provides independent, 3rd party credible validation of green marketing claims. UL Environment addresses various types of environmental claims, some of which include: recycled content, energy efficiency, water efficiency, and others.



Fig. 1: Carrier NaturaLINE Units

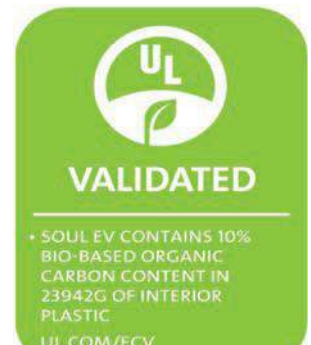


Fig. 2: UL Environment Validation

The innovation had been hailed as a landmark by the shipping and container refrigeration industry.

Use of Multi-stage Compressors

NaturaLINE also uses multi-stage Compressors which is a significant step in technological advancement for Container Refrigeration.



Chilukuri Maheshwar is a practising Marine Engineer, working as Faculty - Engineering at Anglo Eastern Maritime Academy, Mumbai belonging to Hong Kong based Anglo Eastern group. He has MBA, MEE (Masters Degree in Ecology and Environment) and MPhil in Management. He is author of book titled Container Refrigeration, & it is recommended as reference book for USCG MARAD's Marine Engineer's Licensing Examination for the subject of Marine Refrigeration and Air Conditioning.



Inverter Technology – Use of Variable Frequency Drives

Have you heard of Inverter ACs! Daikin has newly introduced them in Indian market and other manufacturers have also followed suit.

Daikin has been the pioneer in introducing this technology for Container Refrigeration. Taking a cue from its Air Conditioner market using Daikin DC Inverter Compressor, in 2011, Daikin introduced its ZESTIA

series of Reefer Container machinery incorporating DC Inverter compressor. Here, the container refrigeration unit's compressor is driven by a motor that rotates at a speed determined by the frequency of the electrical power supply. An inverter system controls the compressor rotation speed by changing the power supply frequency and provides precise temperature control with low power consumption. This was the first scroll compressor to be equipped with the DAIKIN Patented Motor.

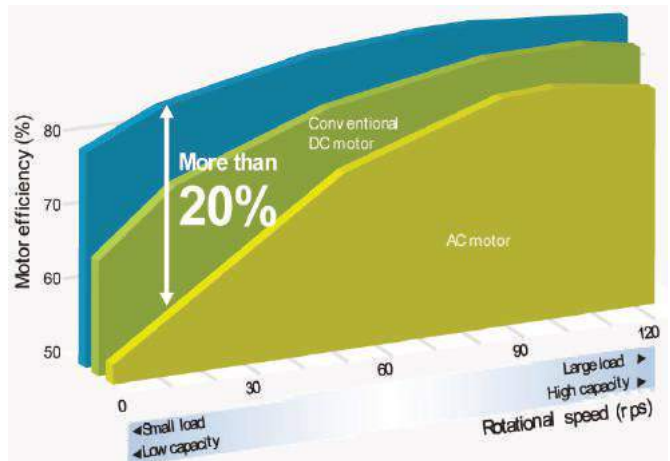


Fig. 4: Daikin DC Inverter Compressor

Hermetic Units

Till recently, we only heard about Hermetic Expansion valves and Hermetic Compressors. Hermetic basically means fully sealed or air tight. The Compressor, receiver, filter drier and valves used to be fitted to the pipelines through flanged nut and bolt connections or threaded connections. With these units, there was always a limitation on the low pressure that the unit could work on. One had to be doubly cautious not to allow the compressor to run in vacuum conditions, especially during maintenance work. There was a limitation of the minimum temperature which could be reached using a particular refrigerant.

However, the new generation of reefer container units are hermetic or completely sealed. The threaded and bolted connections have been replaced with brazed connections not allowing even a single joint to be opening to atmospheric pressure and drawing air and moisture into the system. Units could be safely run in negative pressures and vacuum conditions. As a result, lower minimum temperatures can be reached with these units for the same refrigerant.

For example, using a PT chart, we can see that R134a goes into vacuum (negative pressure) at temperatures below -25.6°C, which becomes a limiting factor for the temperature that can be reached using R 134a. However, in units with fully sealed or hermetic units, the minimum temperature which can be reached is as low as -30°C. At this temperature, R134a will be at a negative pressure or at 4.9 inches of mercury vacuum. Since, it is a fully sealed unit, even at this pressure there is no chance of ingress of air or moisture into the system.

Most of the Reefer Container Manufacturers have adopted Hermetic Units and are able to give lower temperatures to the customers with the refrigerants safely and efficiently.

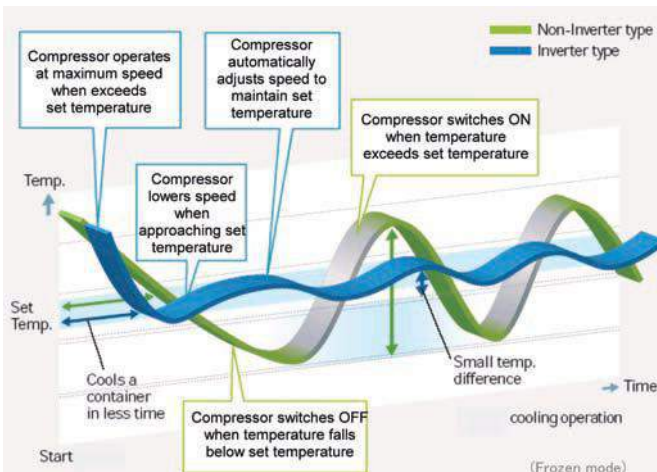


Fig. 3: Compressor Cooling Characteristics using Inverter vs Non-Inverter Motors

An inverter enables rapid cooling, maintains a stable set temperature, and has a significant energy-saving effect.

DAIKIN Patented Motor features powerful neodymium magnets that claim to improve motor efficiency at all rotational speeds for energy-saving operation, particularly during the operation at low frequencies.

R-134a							
Degrees F	Degrees C	PSIG	BARS	Degrees F	Degrees C	PSIG	BARS
-40	-40.0	<u>14.50</u>	<u>1.00</u>	56	13.3	52.30	3.61
-38	-38.9	<u>13.70</u>	<u>0.95</u>	58	14.4	55.00	3.80
-36	-37.8	<u>12.80</u>	<u>0.88</u>	60	15.6	57.50	3.97
-34	-36.7	<u>11.80</u>	<u>0.81</u>	62	16.7	60.10	4.15
-32	-35.6	<u>10.80</u>	<u>0.75</u>	64	17.8	62.70	4.33
-30	-34.4	<u>9.70</u>	<u>0.67</u>	66	18.9	65.50	4.52
-28	-33.3	<u>8.60</u>	<u>0.59</u>	68	20.0	68.30	4.71
-26	-32.2	<u>7.70</u>	<u>0.53</u>	70	21.1	71.20	4.91
-24	-31.1	<u>6.20</u>	<u>0.43</u>	72	22.2	74.20	5.12
-22	-30.0	<u>4.90</u>	<u>0.34</u>	74	23.3	77.20	5.33
-20	-28.9	<u>3.60</u>	<u>0.25</u>	76	24.4	80.30	5.54
-18	-27.8	<u>2.30</u>	<u>0.16</u>	78	25.6	83.50	5.76
-16	-26.7	<u>0.80</u>	<u>0.06</u>	80	26.7	86.80	5.99
-14	-25.6	0.30	0.02	82	27.8	90.20	6.22
-12	-24.4	1.10	0.08	84	28.9	93.60	6.46
-10	-23.3	1.90	0.13	86	30.0	97.10	6.70
-8	-22.2	2.80	0.19	88	31.1	100.70	6.95
-6	-21.1	3.60	0.25	90	32.2	104.40	7.20
-4	-20.0	4.50	0.31	92	33.3	108.20	7.47
-2	-18.9	5.50	0.38	94	34.4	112.10	7.73
0	-17.8	6.50	0.45	96	35.6	116.10	8.01
2	-16.7	7.50	0.52	98	36.7	120.10	8.29
4	-15.6	8.50	0.59	100	37.8	124.30	8.58
6	-14.4	9.60	0.66	102	38.9	128.50	8.87
8	-13.3	10.80	0.75	104	40.0	132.90	9.17
10	-12.2	12.00	0.83	106	41.1	137.30	9.47
12	-11.1	13.10	0.90	108	42.2	142.80	9.85
14	-10.0	14.40	0.99	110	43.3	146.50	10.11
16	-8.9	15.70	1.08	112	44.4	151.30	10.44
18	-7.8	17.00	1.17	114	45.6	156.10	10.77
20	-6.7	18.40	1.27	116	46.7	161.10	11.12
22	-5.6	19.90	1.37	118	47.8	166.10	11.46
24	-4.4	21.40	1.48	120	48.9	171.30	11.82
26	-3.3	22.90	1.58	122	50.0	176.60	12.19
28	-2.2	24.50	1.69	124	51.1	182.00	12.56
30	-1.1	26.10	1.80	126	52.2	187.50	12.94
32	0.0	27.80	1.92	128	53.3	193.10	13.32
34	1.1	29.50	2.04	130	54.4	198.90	13.72
36	2.2	31.30	2.16	132	55.6	204.70	14.12
38	3.3	33.20	2.29	134	56.7	210.70	14.54
40	4.4	35.10	2.42	136	57.8	216.80	14.96
42	5.6	37.00	2.55	138	58.9	223.00	15.39
44	6.7	39.10	2.70	140	60.0	229.40	15.83
46	7.8	41.10	2.84	142	61.1	235.80	16.27
48	8.9	43.30	2.99	144	62.2	242.40	16.73
50	10.0	45.50	3.14	146	63.3	249.20	17.19
52	11.1	47.70	3.29	148	64.4	256.00	17.66
54	12.2	50.10	3.46	150	65.6	263.00	18.15

Fig. 5: R-134a PT Chart (Underlined Values Indicate Vaccum (IN of HG, MM of Mercury))

Passive Refrigeration Concept

New technology for global transport temperature control that doesn't use external energy supply while in operation.

In November 2014, Thermo King, a manufacturer of transport temperature control solutions for a variety of mobile applications and a brand of Ingersoll

Rand, unveiled its new passive refrigeration technology, a new autonomous refrigeration concept for intermodal applications. Patented by Thermo King, passive refrigeration combines the best of intermodal transportation solutions – the operational simplicity of a dry container with the cooling capacity and functional benefits of a reefer. Uniquely, this system uses a food-grade eutectic solution to store thermal energy for completely autonomous operation during transport.

With no need for plugging and unplugging, like in case of a conventional reefer, passive refrigeration ensures the cargo is transported at the right temperature and humidity conditions to preserve the quality of fresh harvested produce, regardless of the region, time or operator. This feature gives the cargo owners access to new markets with limited or inadequate conventional reefer services.

This technology offers:

- Continuous cold chain operations. The autonomous operation for sea transport & post-harvest applications enables uninterrupted temperature control for reliable transport of fresh meat, fruit and vegetables, pharmaceuticals and flowers.
- Optimal quality & reduced weight-loss. Natural convection eliminates the need for forced ventilation, thereby maintaining the desired humidity levels and preserving the freshness and weight of perishables.
- Reduced cost of ownership. The absence of moving parts results in lower maintenance and Pre-Trip Inspection (PTI) cost, and the autonomous operation results in simplified operations and lower handling cost.

Why Eutectic Technology Eutectic Refrigeration

We all know that a drink with ice in it will stay cold and drinkable at a constant temperature while the ice remains, but will warm rapidly once the ice thaws.

The ice is an example of the eutectic principle, absorbing relatively huge amounts of heat while it thawed from a solid to a liquid. (Phase changed).



Fig. 6: Principle of Eutectic System

The term 'Eutectic System' refers to a refrigeration system that uses the phase change of a liquid medium to absorb and dissipate large amounts of thermal energy while remaining at a constant pre-arranged temperature. Phase Change occurs when we freeze a solution solid by removing its heat or as it thaws into a liquid again while it absorbs heat. The phase change medium or eutectic solution is stored in the stainless steel eutectic plate and acts like a re-new able ice block, freezing solid during the refrigeration run cycle & thawing during off periods and all the time maintaining a constant cabinet temperature like the ice did for the cool drink!

Other products such as a thin aluminum evaporator plate can also absorb and dissipate thermal energy but when a relatively large volume of solution is used and it is allowed to freeze solid on the refrigeration run cycle, then thaw during the off cycle, a massive amount of stored thermal energy is in play. By comparison with a thin aluminum cold plate, the first and most obvious advantage the eutectic system has is its far greater mass and therefore thermal hold-over storage capacity. (A thin slice of ice will disappear much quicker than a 60 mm thick block would). But this thermal storage advantage pales into insignificance compared to the other unique benefit that the eutectic system's phase change phenomenon delivers. This phenomenon called 'Latent heat', multiplies the eutectic's thermal storage capacity many times providing huge hold-over periods where the unit stays off for many hours even days in cooler times.

As an example, using a quantity of water as a eutectic solution and knowing that water's phase change occurs at approximately 0°C , this water will absorb and dissipate 80 times as much thermal

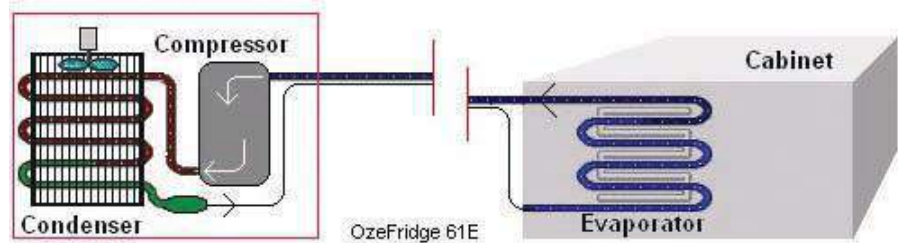


Fig. 7: Layout of Eutectic System

energy while freezing and thawing as it would for any other rise or fall of a degree centigrade.

(All eutectic solutions with a colder phase change point than water also have a lower Latent Heat value. Expect lower temperature eutectic mixes to absorb & dissipate approximately 65 to 70 watts while phase changing).

A eutectic system will run for a long period while refrigerating the eutectic solution until frozen solid. It then stays off for relatively much longer periods while this thermal mass thaws completely before running again, all the time maintaining cabinet temperature.

Advantages of Eutectic systems

- Long 'hold-over' off periods due to the large thermal mass and more importantly because of the eutectic's phase change.
- Refrigeration can be at a time that suits the power supply, or during cooler periods when refrigeration systems are more efficient.
- Much lower overall power consumption due to more efficient refrigerant evaporation in a saturated environment.
- With ECO_2 the eutectic mass is automatically refrozen whenever sources of power are abundant, reducing demand on batteries.
- Virtually 'cooling in advance', use of abundant power supplies provides a day or so of refrigeration requirement in storage.
- A day or two of sailing without the need of additional cooling is possible if battery power supply is down. (i.e. solar but no sun).
- Eutectic systems store energy at a third of the weight that would be required in batteries to provide the same refrigeration effect.
- Refrigerant gas is pumped around



Fig. 8: Cut-away Section of a Multi-voltage compressor

the system by the compressor, in a re-circulating manner somewhat similar to water circulating around a cars cooling system, collecting heat from one area and disposing of it in another.

- The three main components are:
 - i: Evaporator (Eutectic cooling pipes, inside the fridge cabinet)
 - ii: Condenser (Disposes heat outside)
 - iii: Compressor pumps the refrigerant gas that transports the heat. These components are connected in a closed loop.
- The evaporator collects heat from the eutectic tank and the compressor pumps / compresses it into the condenser where it is disposed of. Therefore, each of these major components relies on the other, each doing their job effectively and proportionately.

For example, if the condenser cannot efficiently dispose of the heat load because it is undersized or has a restricted air / water flow etc., then the compressor is overloaded and stressed, the evaporator is unable to collect heat effectively and so on. The result of this chain reaction is a system that consumes excess power and provides poor, if any, refrigeration. Systems must be engineered with compatible components. In future, perhaps, we will be seeing more applications of Eutectic Refrigeration for Reefer Container Machinery. ■



Cool Roofing

When comfort and laziness styles of living beat tolerant and austerity life styles then human fails to cope up with the existing/prevaling environmental/seasonal changes all around and thus, technology remains the only answer for the wrong boos of changing lifestyle.

Summer and winters seasons always concern people more than other seasons and they get serious to cope up with these severities of climate using technology. In winter people can make use of more clothes but summer can be overcome by using electrical driven cooling appliances like Fans, Coolers, ACs and Fridges etc. But with the summers getting hotter (due to global warming) and growing electricity demand, people are forced to think about some future innovations which can be useful to beat the summer heat in more economical and effective way. A warming world needs cooling technologies that don't require power. Cosmic fridge is such a new technique to design buildings with high-tech mirror which can beams heat away from buildings into space. Such a technology can prove to be a boon for people living in very hot zones of the country like Punjab, Haryana, Rajasthan, parts of Bihar & UP, Madhya Pradesh, Odissa, West Bengal, Jharkhand and Gujarat. Across the developing world, photonic radiative cooling makes off-grid cooling a possibility in rural regions, in addition to meeting skyrocketing demand for air conditioning in urban areas.

Summer heating

Much of the human population on Earth lives in sun-drenched regions huddled around the equator. Electrical demand to drive air conditioners is skyrocketing in these places, presenting an economic and an environmental challenge. These areas tend to be poor and the power necessary to drive cooling usually means fossil-fuel power plants that compound the greenhouse gas problem. In addition to these regions, we can foresee applications for radiative cooling in off-the-grid areas of the developing world where air conditioning is not even possible at this time. There are large numbers of people who could benefit from such systems. Forty-fifty percent of the total consumption of energy takes place in buildings, so reducing this consumption is becoming increasingly important. Integrating renewables into the energy supply for buildings is a further step towards moving towards this aim. People usually see space as a source of heat from the sun, but away from the sun outer space is really a cold, cold place. A new type of structure reflects the vast majority of sunlight, while at the same time it sends heat into that coldness, which cools human made structures even in the day



Dr S S Verma, working as Associate Professor in the Sant Longowal Institute of Engineering and Technology is MSc and a PhD from IIT Delhi. He did postdoctoral studies in Japan at Toyohashi University of Technology. He has published about 40 research papers in journals and about 400 science and technology related articles. He has been nominated for various awards by International Biographical Centre (UK).

time. Such a panel could vastly improve the daylight cooling of buildings, cars and other structures by radiating sunlight back into the chilly vacuum of space. First, the reflector has to reflect as much of the sunlight as possible. The second challenge is that the structure must efficiently radiate heat back into space. Thus, the structure must emit thermal radiation very efficiently within a specific wavelength range in which the atmosphere is nearly transparent. Outside this range, Earth's atmosphere simply reflects the light back down. The new structure accomplishes both goals. It is an effective a broadband mirror for solar light -- it reflects most of the sunlight. It also emits thermal radiation very efficiently within the crucial wavelength range needed to escape Earth's atmosphere.

Technology

Engineers have invented a material designed to help cool buildings. The material reflects incoming sunlight on sunny days and sends heat from inside the structure directly into space as infrared radiation. A new ultrathin multilayered material can cool buildings without air conditioning by radiating warmth from inside the buildings into space while also reflecting sunlight to reduce incoming heat. The heart of the invention is an ultrathin, multilayered material that deals with light, both invisible and visible, in a new way. Invisible light in the form of infrared radiation is one of the ways that all objects and living things throw off heat. When we stand in front of a closed oven without touching it, the heat we feel is infrared light. This invisible, heat-bearing light is what the Stanford invention shunts away from buildings and sends into space. The new material, in addition to dealing with infrared light, is also a stunningly efficient mirror that reflects virtually all of the incoming sunlight that strikes it. The results will cooler buildings that require less air conditioning. The researchers say they designed the material to be cost-effective for large-scale deployment on building rooftops. Though it's still a young technology, they believe it could one day reduce demand for electricity. In practice the researchers

think the coating might be sprayed on a more solid material to make it suitable for withstanding the elements.

The research team has succeeded by turning to nano structured photonic materials. The material is made of quartz and silicon carbide, both very weak absorbers of sunlight. These materials can be engineered to enhance or suppress light reflection in certain wavelengths. The thermal emitter and solar reflector are combined into one device, making it both higher performance and much more robust and practically relevant and this design makes viable both industrial-scale and off-grid applications. But transmitting heat into space is not enough on its own. This multilayered coating also acts as a highly efficient mirror, preventing 97% of sunlight from striking the building and heating it up. Together, the radiation and reflection make the photonic radiative cooler nearly 9 degrees Fahrenheit cooler than the surrounding air during the day. The multilayered material is just 1.8 microns thick, thinner than the thinnest aluminum foil. It is made of seven layers of silicon dioxide and hafnium oxide on top of a thin layer of silver. These layers are not a uniform thickness, but are instead engineered to create a new material. Its internal structure is tuned to radiate infrared rays at a frequency that lets them pass into space without warming the air near the building. Radiative cooling has another profound advantage over all other cooling strategy such as air-conditioner. It is a passive technology. It requires no energy. It has no moving parts. It is easy to maintain. Put it on the roof or the sides of buildings and it starts working immediately.

In another research, a new type of durable, environmentally-benign blue pigment has been discovered at Oregon State University with unusual characteristics in reflecting heat. It's a

cool blue compound that could become important in new approaches to saving energy in buildings. Its potential use to help reduce heat absorption on the roofs and walls of buildings -- which is an evolving field of considerable interest in warm regions where cooling is a major expense -- adds another role for the material, which is now being considered for various commercial applications. This pigment has infrared heat reflectivity of about 40%, which is significantly higher than most blue pigments now being used.

Net cooling power

The new device is capable of achieving a net cooling power in excess of 100 watts per square meter. By comparison, today's standard 10 percent efficient solar panels generate the about the same amount of power. That means Fan's radiative cooling panels could theoretically be substituted on rooftops where existing solar panels feed electricity to air conditioning systems needed to cool the building. To put it a different way, a typical one-story, single-family house with just 10% of its roof covered by radiative cooling panels could offset 35% its entire air conditioning needs during the hottest hours of the summer.

Development bottlenecks

Making photonic radiative cooling practical requires solving at least two technical problems. The first is how to conduct the heat inside the building to this exterior coating. Once it gets there, the coating can direct the heat into space, but engineers must first figure out how to efficiently deliver the building heat to the coating. The second problem is production. Right now the prototype is small in size and cooling buildings will require large panels. The researchers say large-area fabrication facilities can make the panels at the scales needed. ■



CGMP and HVAC Energy Audit

- Case Study of Pharmaceutical Industry

Regulatory and cGMP compliances have been areas of concern to the Indian pharmaceutical industry. This case study highlights the findings and solutions of cGMP, and energy performance gap analysis.

ECPL engineers performed site walk-through audit and performed detailed data logging for a Parenteral Manufacturing Area (PMA) located in India. In addition utility analysis was conducted to identify actual maximum and minimum demand of various utilities and equipment efficiency of utility systems.

cGMP Gap analysis

Improper clean room classification based on cGMP and regulatory requirements

It was observed that due to miscommunication between the QA and engineering department, certain change rooms were maintained as Grade C instead of Grade B. This issue was identified and the system capacity verified to provide increased air flow to the air lock.

Improper access to mechanical area for ovens

It was observed that there was no proper access to mechanical area for the ovens. The mechanical area was unclassified and was accessed through one of the Production area. It was suggested that separate access to the mechanical area with ventilation system to be provided to comply with cGMP requirements.

Improper pressure cascade with acceptance criteria as per GMP

There was no proper acceptance criteria provided for pressure cascade system in order to be practically feasible to implement. Thorough study of the operation with revised pressure cascades was prepared.

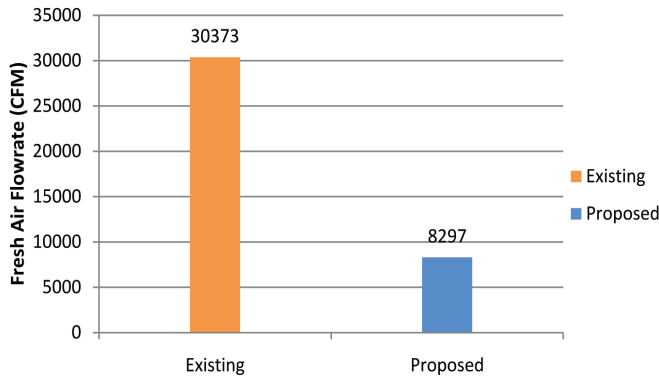
The tank turnaround time was found to be about 0.7 / hour which is approximately 3 times less than acceptable turnaround

as per GMP. Proper sizing of tanks was recalculated and provided for future modification.

Energy Efficiency and Performance Gaps

Excessive fresh air intake to maintain zone pressure

The actual fresh air being pumped is 30,373 cfm, whereas the required fresh air intake is calculated to be only 8,297 cfm. The total fresh air load on the chilled water system was calculated to be about 78.3 TR.



Measured and Suggested Fresh Air Flowrates

Reducing the fresh air intake saves approximately 57 TR in cooling energy. This amounts to an annual cost of 16 lac rupees.

Excessive steam consumption for de-humidification

The areas where steam was used for de-humidification were found to be maintained at a much lower humidity set point (40%) than necessary. It was found that the necessary



Steam Consumption Before and After Optimization of Steam use for Dehumidification

Rajesh Deshpande, Managing Director of Energetic Consulting Pvt Ltd (ECPL), is B.Tech Chemical Engineering.

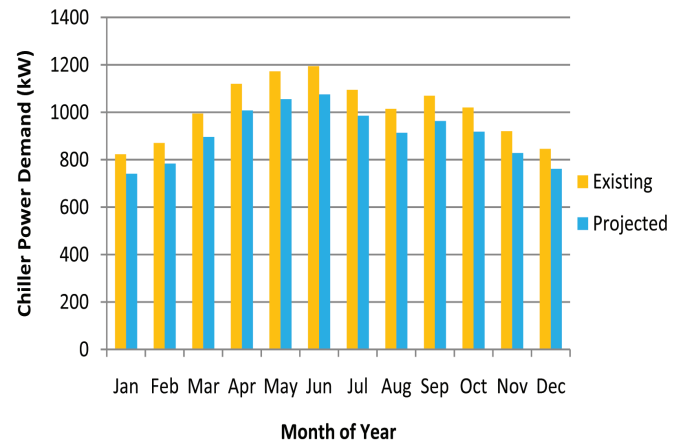


dehumidification can be achieved using latent free designs with chilled water or DX-type units.

Nearly 30% of the steam generated was consumed for dehumidification using desiccant systems. This amounts to an annual cost of 84 lac rupees.

Chilled water system efficiency

The installed cooling capacity of the chillers is approximately 2400 TR. Some of these chillers were new energy efficient chillers. However due to lack of optimization techniques, it was found that the most energy efficient chillers were partially loaded and operating at lower efficiencies.



Chilled Water System Power Consumption

The chilled water system was found to have a maximum load of 68% of the installed capacity with a specific power consumption of 0.722kW/TR.

The proposed chiller sequencing scheme can achieve a specific power consumption of 0.65 kW/TR.

In addition to this appropriate selection of optimally sized new chiller pumps with good efficiencies at the operating points can reduce pumping power by 60 kW. This amounts to annual cost savings of 98.5 lacs.

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International Training Center



One of the SCHAUFLEER Academy highlights will be innovative energy concept, featuring heat pumps for heating and cooling, underground latent storage (ice storage), the solar thermal collector and the block-type thermal power station



SCHAUFLEER academy will serve as a representative reception building for the Rottenburg production facility

BITZER is pursuing its strategy to expand the training facility, now in construction phase 8 of the SCHAUFLEER Academy, the international training center, at the Rottenburg-Ergenzingen location, that kicked off in August 2014. Measuring 1,500 sq mtr, the innovative facility is scheduled for completion in October 2015. "With the construction of the SCHAUFLEER Academy in Rottenburg, BITZER is clearly demonstrating its intention to continue investing in this region in the future," explains Jürgen Kleiner, Chief Procurement Officer at BITZER.

Rainer Große-Kracht, Chief Technology Officer at BITZER says, "We decided to build the SCHAUFLEER Academy for many different reasons". The complexity of BITZER compressors and products is always increasing, for example due to the integrated frequency inverters, electronic components and new CO₂ systems. Technically demanding solutions also require a well-trained service staff. The SCHAUFLEER Academy will be the central training location for customers and employees from all over the world. Here we will offer the training courses that keep the maintenance teams of our business partners up to date.

Multifunctional

SCHAUFLEER Academy was designed to be a multifunctional building, it will also be the new main entrance and representative reception building for the entire factory, providing the location with a unique ambience.

A major advantage of the three-story, ten-meter-tall SCHAUFLEER academy is that it can host several training courses at the same time as it offers five rooms for teaching the necessary theory and three for practical training. BITZER planned the SCHAUFLEER academy to be a multifunctional building in order to make optimal use of all the new space. For instance, three training rooms can be combined to create a larger space with enough seating for up to 60 people. The SCHAUFLEER academy will also serve as a representative reception building for the Rottenburg production facility.

"The training courses offer a variety of benefits: BITZER can

present the theory behind the added value provided by cutting-edge compressors and electronic components as well as demonstrate the practical advantages when used with new technologies and carry out testing on real systems," says Große-Kracht.

BITZER will also showcase its latest products at the SCHAUFLEER academy, including the CSVH compact screw compressor and the ORBIT 6 scroll compressor in practical applications for heating and cooling. The specialist in refrigeration compressors also designed the SCHAUFLEER Academy to offer space for offices for the training staff and a company restaurant with seating for 110 employees and training course participants.

Innovative Energy Concept

One of the SCHAUFLEER Academy highlights will be the innovative energy concept, featuring heat pumps for heating and cooling, underground latent storage (ice storage), the solar thermal collector and the block-type thermal power station. Having pursued sustainability for quite some time, the company is now demonstrating how cutting-edge environmental protection works. "We're happy to assume higher investment costs for the ice storage, for example," says Kleiner. "We use it to collect temporarily available cooling and thermal energy and retrieve it again when necessary. This allows us to compensate for the fluctuating energy supply and use renewable energy sources that are suitable for heating and occasionally for cooling. Of course we also use the existing waste heat released by the testing and demonstration systems." The concept also has additional benefits, it is eco-friendly, does not require any approval processes and can also be used in water protection areas.

Named after BITZER CEO Peter Schaufler, Peter-Schaufler-Strasse leads to the current large-scale project – the SCHAUFLEER Academy – and will be the new address of the Rottenburg-Ergenzingen location following completion of construction. ■

Danfoss appoints new Senior Director of Sales and Marketing



Danfoss, a leading manufacturer of high-efficiency electronic and mechanical components and controls for air-conditioning, heating, refrigeration, industrial, and water systems, has appointed Joseph Rich as

senior director of sales and marketing, North America. In this role, Rich will focus on growing the company's VLT Drives business in the North American market, providing leadership and directing strategy for both sales and marketing. He also will continue to strengthen customer relationships and develop programs to continue to build loyalty for Danfoss products and services. Rich will be based out of Danfoss' Milwaukee office.

Danfoss VLT Drives are used around to optimize processes & reduce energy use in HVAC, refrigeration, water and wastewater, food and beverage, mining,

lift and crane, chemical, and marine applications. In North America, Danfoss manufactures and tests small/medium variable frequency drives (<90kW) for the U.S. market and high-powered VFDs (>90kW) for the global market at its facilities in Loves Park, Illinois and Milwaukee, Wisconsin. Recently, Rich was district manager for Northwestern United States at Rockwell Automation, where he also held several sales director positions. He also has held sales positions at the B.W. Rogers Company and Parker Hannifin. He holds an MBA and bachelors' in mechanical engineering from the University of Akron. ■

Dr. James Crisp joins as Accreditation Specialist at HVAC Excellence

HVAC Excellence is pleased to announce the addition of Dr. James Crisp as an Accreditation Specialist. There are currently accredited programs in 32 states. As the demand by public and private Community Colleges, Technical Colleges and Career Centers to validate the quality and integrity of their programs through HVAC Excellence continues to grow, so must the HVAC Excellence accreditation team.

Accreditation specialists are part of a two member onsite team, one who has served years as an HVACR instructor, the



Dr James Crisp - Far Left

other as a school administrator. These onsite team members are seasoned professionals that possess the knowledge, training and experience to successfully evaluate every aspect of an

HVACR program. Dr. Crisp has been involved in career and technical education for over 30 years. His experience at the post-secondary level includes: Coordinator for Educational Programs at the Technical College System of Georgia, Instructional Coordinator at Oconee Fall Line Technical College. His experience at the secondary level includes classroom instructor for Construction Trades, Industrial Arts, and Industrial Technology. Dr. Crisp will be an excellent resource for the programs seeking accreditation. ■

VR Systems has two new appointments



Viessmann Refrigeration Systems (VRS) has appointed Steve Steadman as sales and marketing director for the UK and Ireland. He will be based in company's Telford head office and will be responsible for driving business development within the organisation.

Steadman has extensive sales and commercial experience of the refrigeration market. He started his career in 1986 with Sainsbury. In 2002

he moved to Scobie & McIntosh, where he had responsibility for sales of refrigeration equipment and associated services. Since 2004 he has been running his own business, selling bakery and refrigeration products to the grocery trade.

Viessmann has also appointed Dan Norton as operations and IT manager for the UK. He will also be based in Telford and will report to Steve Steadman. ■



Switzerland shows tradition of advocating Natural Refrigerants

Outstanding energy standards and legislation demanding sustainable refrigeration and air-conditioning solutions definitely play an important role. But a significant contribution also comes from the innovation commitment of planners, combined with great willingness on the part of operators to implement new technologies. Towards demanding legislation and trend-setting projects – in this portrait, eurammon shows why Switzerland has a tradition of advocating natural refrigerants. In view of the revised F-Gas Regulation, the refrigeration and air-conditioning branch is looking to change over to environmentally-friendly and viable applications that are also economically profitable. Switzerland is a major pioneer in this respect. But what exactly has put the Alpine state in this position!

Statutory restrictions for refrigerants impacting on the climate

In Switzerland, the Ordinance on Chemicals Risk Reduction regulates the use of substances said to be stable in air – volatile fluorinated hydrocarbons with a half-life period in air of more than two years. This includes nearly all fluorinated refrigerants apart from R-152a and many HFOs. A further tightening of the regulation means that since the end of 2013, there is also a partial ban on systems that run on refrigerants with high global warming potential. "Emissions from



Fig. 1: The large stratified storage tanks in Churwalden have a capacity of 30,000 litres.

refrigerants impacting on the environment must be avoided as far as possible in technical and economic terms. To this end, we have adjusted the prohibitions according to current state-of-the-art engineering to make them demanding but still feasible", says Blaise Horisberger from the Federal Office for the Environment (FOEN). In practice, this ban affects industrial refrigeration systems above 400 kW, commercial refrigeration systems from smaller capacity ranges, air-conditioning systems and thermal pumps above 600 kW and also artificial ice rinks. "According to our estimates, the current regulation should result in natural refrigerants and HFOs accounting for about two thirds of the installed quantity of refrigerants in the long term", says Horisberger. "If natural refrigerants continue to be used with such success, there is a good chance that users in future will opt mainly for ammonia, CO₂ and CO."

Smart use of synergies: ammonia for refrigeration and heating

An altogether positive example for using natural refrigerants can be found south of Chur with Fleischrocknerei Churwalden AG, a meat-drying company located at 1,000 metres above sea level. In order to make the most sustainable possible use of resources, the building has been successively brought in line with the very latest technical standards. To this end, the company also installed a new refrigeration system – of course with ammonia. "Many of our customers want a solution with natural refrigerants to ensure they can use their system in the long term – this also applies to Fleischrocknerei Churwalden", reports Beat Schmutz, Managing Director of the eurammon member SSP Kälteplaner AG. Both heat energy and refrigeration energy is needed all year round to dry the meat, so that SSP Kälteplaner advocated an integral building concept that uses the waste heat from the new



Fig. 2: The new ammonia plant at Fleischrocknerei Churwalden combines refrigeration and the use of waste heat.

refrigeration system for heating and hot water. The waste heat from generating compressed air and refrigeration is collected in a large stratified storage tank that can hold 30,000 litres. From here, the waste heat is then distributed at selected temperatures to the individual distribution units. Fleischrocknerei Churwalden is now almost in a position to manage without the old oil boiler system that used to generate most of the heat energy. It is now only used to cover peak demand. As a result, annual oil consumption has sunk by 70%. The massive reduction in CO₂ emissions is similarly impressive. The new system saves a full 320 tonnes CO₂, thus making a considerable contribution to climate protection.

Tradition of supermarket refrigeration with natural refrigerants at Migros

Energy-efficient, low-cost and kind to the climate: when it comes to commercial refrigeration, operators such as Migros, one of Switzerland's largest supermarket chains, show the way. Migros has been using ammonia systems and various CO₂ solutions for both deep-freezing and chilling already since 1994. Today CO₂ is the standard refrigerant, used in more than 370 systems at over 277 supermarkets – mostly as a CO₂ booster system with waste heat exploitation. Numerous stores can only be heated by this waste heat. The reasons for the long tradition of systems with



Fig. 3: CO₂ systems and chilling cabinets with glass doors help Migros save a lot of energy.

natural refrigerants are to be found in a holistic climate and energy strategy: "Our aim is to achieve a 20% reduction in direct and indirect emissions of greenhouse gases by 2020, compared to 2010", explains Urs Berger, Head of Energy and Building Systems at Migros. "In the end, direct greenhouse emissions can only be eliminated with a natural refrigerant such as carbon dioxide". Energy efficiency is just as important for commercial refrigeration. Here there has been a clear increase at Migros. Before introducing the CO₂ technology, the target refrigeration index was 4,000 kW/m x a, which refers to the electricity consumed by the refrigeration system per system length in metres and year. "Meanwhile our current targets have fallen to between 2,000 and 2,700 kWh/m x a, thanks to the efficiency of our systems", says Berger. Massive reductions



Fig. 4: An indirect ammonia system with a refrigeration capacity of approx. 1.2 MW cools the ice rinks and a curling arena.

in operating costs are another financial argument in favour of these systems. The specific CO₂ safety requirements are fulfilled by the refrigeration system manufacturers and by the operators. "Every change in technology also entails a learning phase. The CO₂ systems have proven their worth in practice and are reliable", emphasises Urs Berger.

First refurbished artificial ice rink in Minergie-Standard

Outdated artificial ice rinks in need of renovation pose a particular challenge. They need huge refrigerating capacity and often impose considerable space constraints on new refrigerating systems. The eurammon member acoenergy has faced up to this challenge in a current project and implemented the very strictest energy standards. The new refrigerating system for a regional ice sport centre in Switzerland's Central Plateau faces demands for maximum energy efficiency and low operating costs together with low investment costs. To this end, acoenergy developed a highly efficient, indirect NH₃ system with a water/glycol blend as secondary refrigerant for cooling the ice rinks and a curling arena with a refrigeration capacity of approx. 1.2 MW. It will be starting operations in two phases in 2016 and 2017, resulting probably in reductions of up to 34% in energy and about 50% in CO₂ emissions. The special thing about the refrigeration system is that it complies with the Minergie-Standard – a voluntary quality guideline for energetically optimised buildings that goes over and beyond the statutory requirements. 23 criteria apply to artificial ice rinks, including for example a minimum waste heat exploitation level of 70%, which has to be verified by means of detailed balance sheets. Provisional certification has already taken place and will be followed by a two-year optimisation



Fig. 5: The regional ice sport centre in Switzerland's Central Plateau will be the first one in Switzerland that fulfills the Minergie-Standard.

phase to give operations the final polish in order to become top-class in energetic terms. "New-build projects for artificial ice rinks are primarily planned on the basis of this voluntary ecological standard", says Stephan Lutz from acoenergy.

Into future with highest standards

Switzerland shows examples of how natural refrigerants can be put to successful use, while fulfilling the strictest energetic standards at the same time. "Switzerland plays this pioneering role because it has forged ahead with the use of natural refrigerants by systematically restricting refrigerants impacting on the climate. The refrigeration branch has taken up this challenge and operators also attach great importance to sustainable refrigeration technology", explains Urs Berger from Migros. In short, Switzerland has managed to meet the challenge of ever tighter statutory requirements – and is looking further ahead to the future. There is still great potential for huge reductions in direct and indirect emissions of greenhouse gases by using natural refrigerants, particularly in small capacity ranges, such as smaller refrigeration or heat pump systems. ■

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Indoor Air Quality

Indoor Air Quality (IAQ) or Indoor Air Pollution refers to the Air Quality within and around buildings and premises used for residential, commercial or factory premises and its surroundings especially as it relates to the health and comfort of its occupants. IAQ can be affected by gases (including carbon monoxide, carbon dioxide, radon, volatile organic compounds that include but are not limited from sources such as smoke, toxic gases, kerosene fumes, unvented and malfunctioning furnaces & stoves, building materials such as paint, furnishings, pollen, varnish etc. personal care products), particulates, microbial contaminants (mold formed due to humidity, bacteria), or any mass or energy stressor that can induce adverse health conditions. Ventilation, filtration and control of source are the primary ways to dilute contaminants for improvement of Indoor Air Quality in most occupied premises. Residential units can further improve indoor air quality by routine cleaning of carpets and area rugs. Cleaning based on traffic, number of household members, pets,

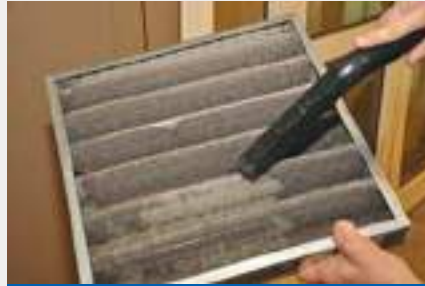


Fig. 2: shows a common air filter used for cleaner air indoors and improving Indoor Air Quality.

children and smokers usually help create a framework guidance for IAQ improvement. Carpets and rugs act like an air filter and must be cleaned.

Determination of IAQ involves the collection of air samples, monitoring human exposure to pollutants, collection of samples on building surfaces, and computer modelling of air flow inside buildings.

IAQ is part of indoor environmental quality (IEQ), which includes IAQ as well as other psychological and physical aspects of life indoors (e.g., lighting, visual quality, acoustics, and thermal comfort).

Indoor air pollution in developing nations is the most deadly risk globally. A major source of indoor air pollution in developing countries is the burning of wood, charcoal, dung, or crop residue for heating and cooking. Estimates indicate approximately 2.2 – 2.5 million deaths occurring annually as a resultant to such high levels of exposure to particulate matter. The majority of deaths occur in the developing nations.

A way of quantitatively ensuring the IAQ is by the frequency of effective turnover of inside air by replacing it with outside air. In the UK, for example, classrooms are required to have 2.5 outdoor air changes per hour. In gymnasiums, physiotherapy spaces and restaurants & dining areas, the ventilation should be sufficient to limit carbon dioxide to 1,500 ppm. In the US, and according to ASHRAE Standards, ventilation in classrooms is based on the amount of outdoor air per occupant plus the amount of outdoor air per unit of floor area, not air changes per hour. Since carbon dioxide indoors comes from occupants and outdoor air, the adequacy of ventilation per occupant is indicated by the concentration indoors minus the concentration outdoors. The value of 615 ppm above the outdoor concentration indicates approximately 15 cubic feet per minute of outdoor air per adult occupant doing sedentary office work where outdoor air contains 385 ppm, the current global average atmospheric CO₂ concentration. In classrooms, the requirements in the ASHRAE standard 62.1, Ventilation for Acceptable IAQ, would typically result in about 3 air changes per hour, depending on the occupant density. Here as we now know the occupants aren't the only source of pollutants, so outdoor air ventilation may need to be higher when unusual or strong sources of pollution exists indoors. When outdoor air is polluted, then bringing in more outdoor air can actually worsen the overall quality of the indoor air and exacerbate some occupant symptoms related to outdoor air pollution.

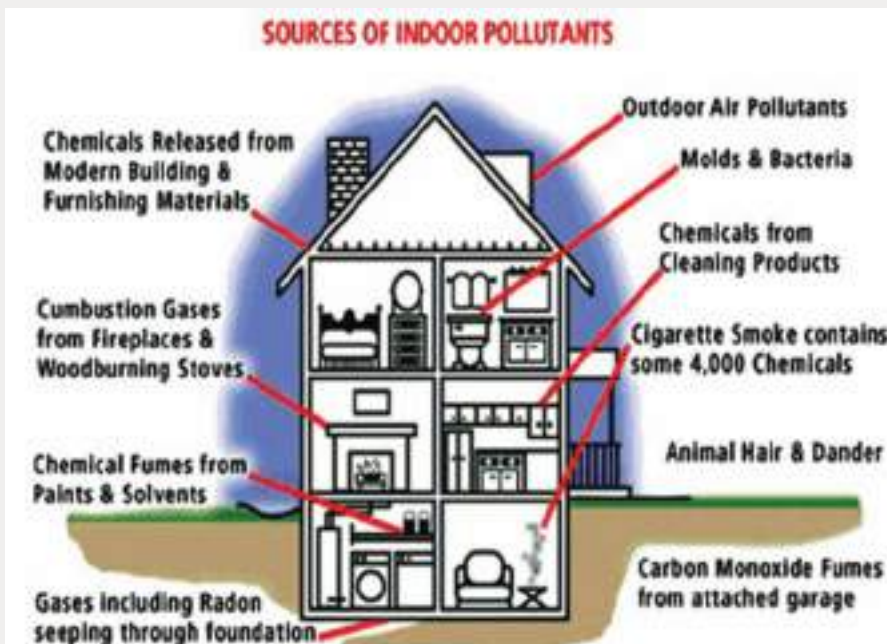


Fig. 1: shows sources of Indoor Air Pollution (Picture courtesy environmentmasters.com)



Fig. 3a: shows an Indoor Air Quality Sensor (VOC).
Courtesy: Telaire



Fig. 3b: Shows CO₂ RH Temperature
Courtesy: Telaire

Generally, outdoor country air is better than indoor city air. Exhaust gas leakages can occur from furnace metal exhaust pipes that lead to the chimney when there are leaks in the pipe and the pipe gas flow area diameter has been reduced.

Moisture management and humidity control requires operating HVAC systems as designed. Moisture management and humidity control may conflict with efforts to try to optimize the operation to conserve energy. For example, Moisture management and humidity control requires systems to be set to supply Make Up Air at lower temperatures (design levels), instead of the higher temperatures sometimes used to conserve energy in cooling-dominated climate conditions. However, for most of the places where during the majority of hours of the year, outdoor air temperatures are cool enough that the air does not need further cooling to provide thermal comfort indoors. However, high humidity outdoors creates the need for careful attention to humidity levels indoors. High humidities give rise to mold growth and moisture indoors is associated with a higher prevalence of occupant respiratory problems.

The “dew point temperature” is an absolute measure of the moisture in air. Some facilities are being designed with the design dew points in the lower 10's °C, and some in the upper and lower 4,5's °C. Some facilities are being

designed using desiccant wheels with gas fired heater to dry out the wheel enough to get the required dew points. On those systems, after the moisture is removed from the make up air, a cooling coil is used to lower the temperature to the desired level.

Commercial buildings, and sometimes residential, are often kept under slightly positive air pressure relative to the outdoors to reduce infiltration. Limiting infiltration helps with moisture management and humidity control.



Fig. 4: Shows a Dewpoint Sensor used for moisture removal/prevention of mold formation.
Courtesy: Telaire NDIR DEW point sensor

Dilution of indoor pollutants with outdoor air is effective to the extent that outdoor air is free of harmful pollutants. Ozone in outdoor air occurs indoors at reduced concentrations because ozone is highly reactive with many chemicals found indoors. Products of reactions between O₃ and many common indoor pollutants include organic compounds that may be more odorous, irritating, or toxic than those from which they are formed. Recent research has shown that mortality and morbidity increase in the general population during periods of higher outdoor ozone and that the threshold for this effect is around 20 parts per billion (ppb).

Institutional Program

A variety of scientists work in the field of indoor air quality including chemists, physicists, mechanical engineers, biologists, bacteriologists and computer scientists. Some of these professionals are certified by organisations such as the American Industrial Hygiene Association, the American Indoor Air Quality Council and the Indoor Environmental Air Quality Council. On the international level, the International Society of Indoor Air Quality and Climate (ISIAQ), formed in 1991, organizes two major conferences, the Indoor Air and the Healthy Buildings series. ISIAQ's journal Indoor Air is published 6 times a year and contains peer-reviewed scientific papers with an emphasis on interdisciplinary studies including exposure measurements, modeling, and health outcomes.

In our country the IAQ awareness is not as high as is in the developed world nevertheless it is not very less as agencies like ISHRAE, ASHRAE, certain NGOs. We are also aware that IAQ is also related to cleanliness with the advent of our Prime Minister's Clean India Campaign (Swachh Bharat Abhiyan) I am sure the awareness for cleanliness and in turn IAQ will be more high and widespread. ■

Courtesy: Sarfraz Panjwani,
Mechanical Engineer from Mumbai is heading ALM Engineering & Instrumentation Pvt Ltd as a Director since 2003.

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Website: www.aitcoolinc.com



Aitcool inc., founded in 2007, is a professional national High-Tech enterprise, specializing in researching, developing and manufacturing refrigeration tools for HVAC/R, with an annual capacity of 30,000 refrigerant recovery machines and 200,000 rotary-vane vacuum pumps at present. AITCOOL has the most professional mechanical, electrical, refrigerating senior engineers.

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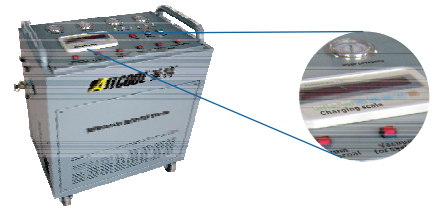
In October 2008, our refrigerant recovery machine project was approved by Ministry of national science and technique.

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Smart Marketing is launching 'SMART' Brand Axial Fans and shaded pole motors during ACREX 2015 in Bangalore. Smart Marketing, Distribution company par excellence with 150 outlets pan-India, has brought this new brand.



These are suitable for Condenser, Evaporator, Refrigeration Equipment's and Ventilating Cycle Areas. Customers looking for reliable quality products will find these Fans & Motors as their first choice. In spite of expensive inputs, these are being offered at attractive launch prices. Smart Axial Fans are available in complete range from 10" size to 18" size in single phase and 18" to 24" Fans in Three Phase. Service life of these fans is over 30,000 hrs. Smart Marketing is offering one year warranty against manufacturing defects on these fans. SMART Shaded Pole motors are having Premium Quality Copper winding with Class 'B' insulation. These can be used for a Temperature range of -30°C to +50°C. These are dual frequency motors, suitable for 50/60 Hz. Both 'SMART' Fans & Motors are having CE and ROHS appraisals. These products come with one year warranty. ■

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Website:
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Website:
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pChrono by Carel

pChrono is the innovative CAREL controller for managing supermarket lights. It can also be used to manage other loads that require precise and customized scheduling. pChrono is completely integrated into the PlantVisorPRO supervisory system.



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pChrono features up to five fully-configurable functions that can be used to meet all specific site requirements. ■

Website:
www.carel.com

ASHRAE, REHVA Jointly Publish Guide to Chilled Beam Systems



Members of Committee that Wrote Book

Standing from Left: John Woollett (Swegon), Sarah Boyle (ASHRAE), Chris Lowell (Halton), Jan Aufderheijde (REHVA), Darryl Boyce (ASHRAE), Carlos Lisboa (BLC Navitas), Julian Rimmer (Price Industries), Peter Simmonds (Building and Systems Analytics), Mick Holland (Ability Projects).

Guidance on designing chilled-beam systems is contained in a new book from ASHRAE and the Federation of European Heating, Ventilation and Air-Conditioning Associations (REHVA).

The "Active and Passive Beam Application Design Guide" is the result of collaboration by worldwide experts to give system designers a current, authoritative guide on successfully applying active and passive beam technology. Building on REHVA's previously published Chilled Beam Application Guidebook, this new guide provides up-to-date tools and advice for designing, commissioning and operating chilled-beam systems to achieve a determined indoor climate and includes examples of active and passive beam calculations and selections. Active and passive beam systems are an energy-efficient solution for spaces that require individual zone control and where the internal moisture loads are moderate." Active and passive beam systems provide good thermal comfort and energy and space saving advantages, and the operation of such systems is simple, with low maintenance requirements," co-editor John Woollett said.

In a building where the goal is a low energy usage index, beams can be an excellent choice of indoor climate product. Although they are often referred to as chilled beams, in many cases active beams can be used for both heating and cooling the space. Active and passive beams are room air recirculation devices that transfer sensible heat to and from the space using water. In addition, conditioned primary air

is ducted to active beams. This primary air must satisfy the ventilation and latent requirements of the space and drive the induction of room air through the beam's coil. In the case of passive beams, this primary air is delivered to the space through a decoupled ventilation system. Active and passive beams may be integrated with acoustic ceilings or independently mounted.

Woollett noted that chilled beams have specific applications and work well in commercial office buildings, schools, hospital patient rooms, laboratories and hotels. He said such systems are common in Scandinavian countries where they are a standard choice of indoor climate delivery in a variety of different applications. The book provides information on the basics of operation but also background from engineers developing the beam technology with manufacturers. The main focus is comfort beam application in their passive and active variants. The cost of the "Active and Passive Beam Application Design Guide" is \$62 (\$53, ASHRAE members).

To order, contact ASHRAE Customer Contact Center or visit www.ashrae.org/bookstore. ASHRAE, founded in 1894, is a global society advancing human well-being through sustainable technology for the built environment. The Society and its more than 50,000 members worldwide focus on building systems, energy efficiency, indoor air quality, refrigeration and sustainability. Through research, standards writing, publishing, certification & continuing education, ASHRAE shapes tomorrow's built environment today. ■

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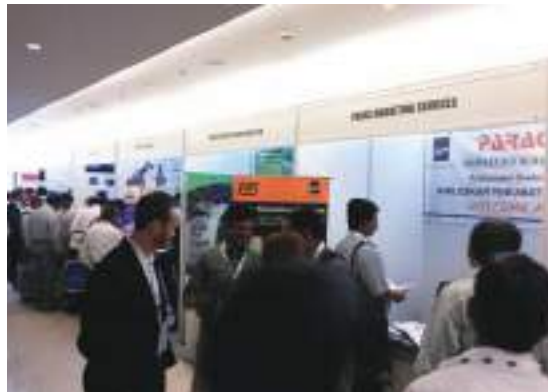


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2nd National Convention on Ammonia Refrigeration Systems



Cooling India attended ARCON 2015 event that turned out to be an insightful one, and involved key benefits as networking latest trends, market trends and of course easy access to those who showcased their offering.

To furnish a better understanding of the use of ammonia as a refrigerant, the association organized 2nd National Convention on Ammonia Refrigeration Systems - ARCON 2015, an International Exposition & Seminar on Indian Refrigeration Industry held at Hotel Four Points by Sheraton, Vashi, Navi Mumbai during January.

Apart from the seminar, Panel Discussions and Product Presentations, the event also included an exhibition wherein various refrigeration products, systems and services were offered to the participants & delegates. This event brought the latest in the industry and the safe practices in Ammonia Refrigeration Systems. Association has the vision to introduce and encourage constructive educational efforts in the fields of design, safety, installation, operation, maintenance, application

and such other subjects as shall furnish a better understanding of the use of ammonia as a refrigerant. To introduce and encourage constructive educational efforts in the field of government affairs, trade association standards and any other groups or associations that establish work rules, standards or guidelines regarding the use of ammonia as a refrigerant.

There were speakers and panel discussion too. Participants included end user, manufacturers, contractors, suppliers, service providers, operation engineers, and design engineers, wholesalers, marketing companies who showcased their offerings and interacted with participants.

Association of Ammonia Refrigeration (AAR) is a national organization, dedicated to promote safe use of ammonia as refrigerant through education, information and standards. Proper knowledge and training of safety standards and latest developments in this field is most important for the people and organizations to understand the efficient use of ammonia refrigeration. ■

Aggreko Energy Rental India Pvt Ltd	69
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Sekisui Foam International	13
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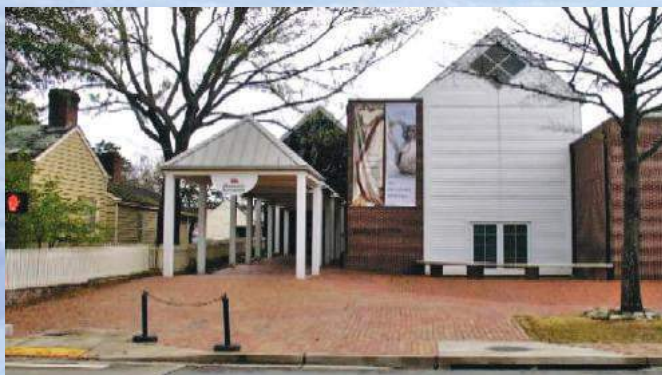
Qatar's world cup stadium will include air cooling technology



The organization responsible for building the stadia and infrastructure for the 2022 FIFA world cup has unveiled renovation plans for the Khalifa International Stadium, the third host venue for the global event. The expansion scheme will increase the arena's seating capacity to 40,000, while innovative

cooling technology inside the design will ensure an optimum playing temperature of 26°C. The venue is to be transformed with a single roof canopy enveloping the structure. Originally built in 1976 on the outskirts of Doha, the venue is to be dramatically transformed with a single roof canopy enveloping the structure. The development also includes a new building added to the stadium's east wing, containing food courts, shops, multi-purpose rooms, VIP lounges and a health center. An on-site museum houses the 3-2-1 Qatar Olympic and Sports Museum, an institution that includes historic sport collections and interactive exhibits. Cooling technology inside the stadium will ensure an optimum playing temperature of 26°C. As part of the overall development, an integrated transport network will take fans from their accommodation to games in less than 45 minutes, while a new road network connects the stadium with public transport. Two further stadia are to be unveiled in the coming weeks, with construction work starting on the five venues before the end of 2014. ■

Historic Ark. Museum installs geothermal heating, cooling



Little Rock's oldest neighborhood is cooled with the latest in green air conditioning technology. Historic Arkansas Museum is completing the installation of a geothermal exchange system utilizing geothermal wells. Once complete, the system will heat and cool three of the museum's historic homes located at Third and Cumberland Streets. The Environmental Protection Agency considers this system the most energy-efficient, environmentally-clean and cost-effective space conditioning system available, factors that make geothermal exchange systems a smart, long-term solution for homeowners and businesses alike. The old units will be removed at 10 a.m. on the first official day of summer, Wednesday, June 20, 2012. Historic Arkansas Museum hosts more than 50,000 visitors every year. The grounds include five primary historic structures and several out buildings that are open to the public, including Little Rock's oldest building, the

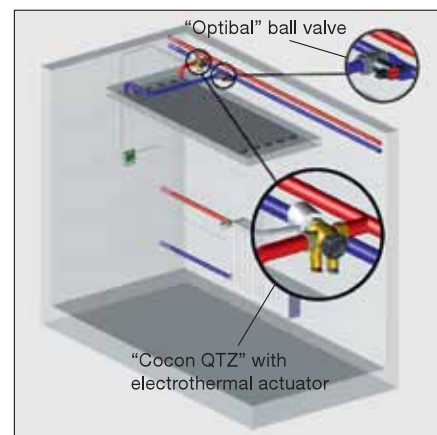
Hinderliter Grog Shop (c. 1827). Maintaining consistent temperatures and humidity levels is critical to preserving the structures and period furnishings. The existing HVAC system is 23 years-old. The museum explored a number of heating and cooling system options and this summer the 1840s Brownlee House, the Woodruff Print Shop complex and the McVicar House will be fitted with a new geothermal exchange system. Director of Historic Arkansas Museum Bill Worthen said for the museum, a major advantage of a geothermal system is esthetics. "By selecting geothermal, the museum was finally freed of the ubiquitous outdoor condensing units, which always remind visitors to the museum that they are not in the 19th century. Geothermal wells also save electricity, so they can be doubly beneficial." Architect Aaron Ruby worked with museum staff and Doug Bowen of MPE Engineers to help develop a suitable system. "A more conventional split system was considered," said Ruby. He said while an advantage of a geothermal system is space and appearance, a special consideration for the museum, there are other advantages that make geothermal systems appealing. "Since these systems use much less electricity, then obviously there is less demand on the local grid, meaning less fossil fuels being burned to generate the electricity," explained Ruby. Less power consumption means lower utility bills. "When you consider what you get from geothermal relative to utility cost, it is one of the most efficient systems available." Geothermal heating and cooling systems work by using the earth's temperature which is constant year round at a certain distance underground. ■

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