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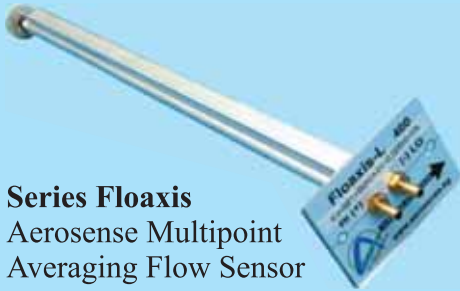
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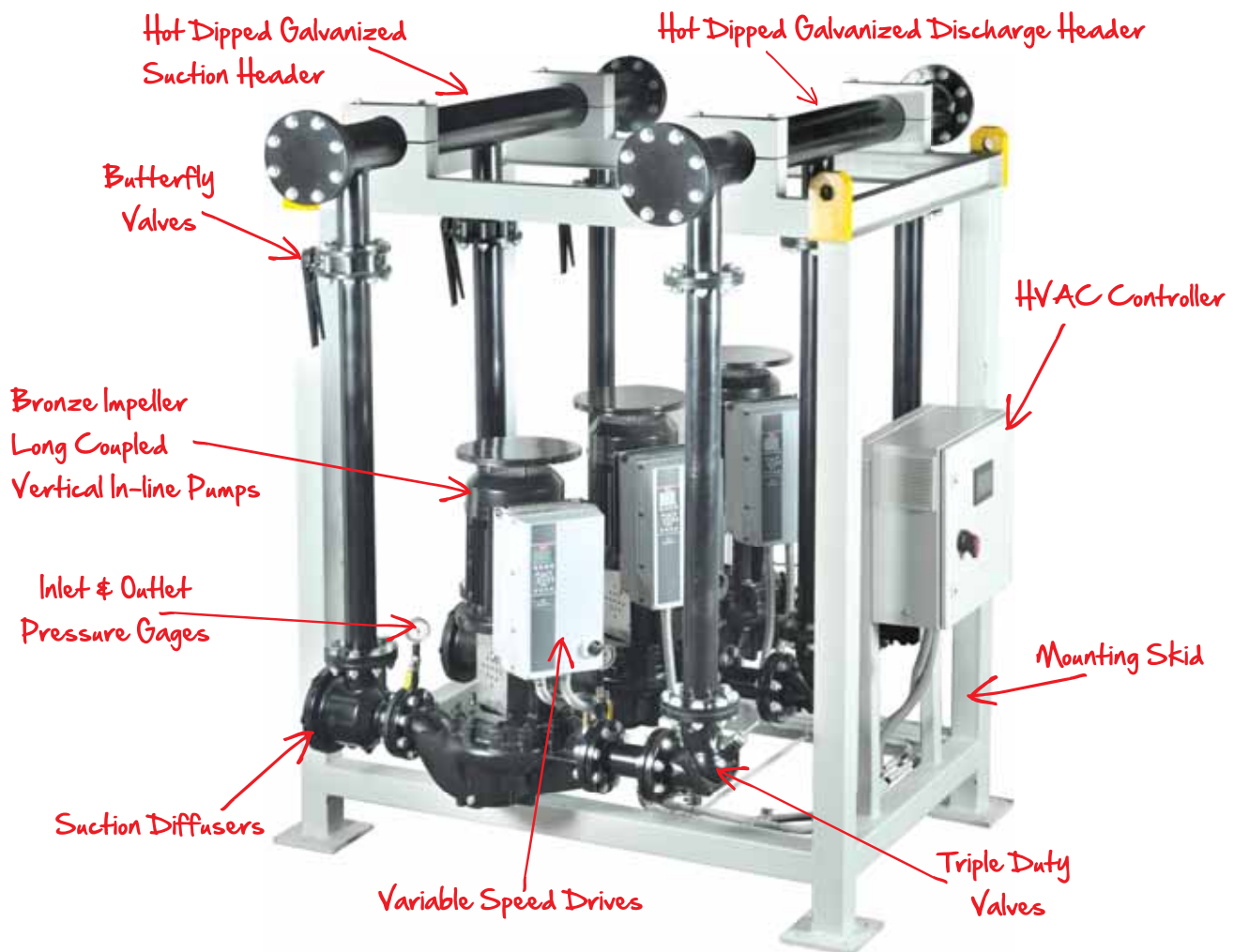
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Publisher's Letter

Hello and welcome once again to *Cooling India*. Cooling towers, which are used to remove excess heat, have become an integral component of an HVAC system of a building. Today, the increasing rate of urbanisation and enhanced standard of living are leading to the large-scale implementation of HVAC systems, thereby driving the market growth globally. According to a report conducted by Grand View Research, the global cooling towers market is expected to reach US\$ 4.85 billion by 2025 whereas a report by MarketsandMarkets estimates that the market will reach US\$ 2.87 billion by 2020 that was US\$ 2.24 billion in 2014, at a CAGR of 4.2% from 2015 to 2020. In India, increase in industrial activities and 100-smart city mission will drive growth for cooling towers industry.

Cooling towers consume significant amounts of water and the cooling system is often a building's largest energy consumer during the cooling season. Therefore, it is essential to achieve cooling tower energy efficiency while maintaining their optimum efficiency. This time, we present you a special report on the basic principles for improving the energy efficiency of cooling towers. The report defines why it is essential to adopt not only proactive maintenance but also condition monitoring approach in the case of cooling tower operation.

Like every other industry, the HVAC industry is going through rapid transformation driven by the growing use of information and communications technology (ICT). Experts believe, the three technological advancements that are changing the way operation and management of chillers and HVAC systems is executed are: Internet of Things (IoT), Big Data analytics and Artificial Intelligence (AI). Here we feature an overview of these disruptors and how the HVAC industry is changing for the better.

Many more such reports on other areas of HVAC industry are also featured herein that will surely be worth reading.

The cold chain industry in India presents huge potential in terms of expansion. On this note, in August, we are coming up with a special issue on cold chain industry in India that will gauge the potential opportunities highlighting the key market trends, technological innovations, product update etc. We are looking forward to your participation in this issue. Do send in your comments to me at pravita@charypublications.in.


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100/- Per Copy
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Sector - 18, Vashi, Navi Mumbai - 400 703.
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Printed by Pravita Iyer and Published by Pravita Iyer on behalf of Chary Publications Pvt Ltd., and Printed at Print Tech, C-18, Royal Ind. Est., Naigaum Cross Road, Wadala, Mumbai 400031 and Published at 906, The Corporate Park, Plot 14&15, Sector - 18, Vashi, Navi Mumbai - 400 703.

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ASHRAE Supports Congressional Resolution Recognising High Performance Building Week

ASHRAE has introduced bipartisan resolutions in the US Senate and US House of Representatives designating June 11–15, as 'High Performance Building Week.' The US Senate resolution was introduced by Senator Ben Cardin (D-MD) and co-sponsored by Senators Corey Gardner (R-CO), Shelley Moore Capito (R-WV), and Chris Van Hollen (D-MD). The US House of Representatives resolution was introduced by Representatives Peter Welch (D-VT) and David McKinley (R-WV), who serve as co-chairs of the High-Performance Building Caucus.

"This resolution recognises the importance of the built environment and celebrates the contributions of engineers, architects, builders, code officials, tradespeople, design and construction professionals," says 2017–18 ASHRAE President Bjarne W Olesen, PhD. "ASHRAE is excited to support High Performance Building Week as we work together to advance innovative building technologies and energy efficiency."

The Congressional resolution supports efforts to improve the performance of existing and future buildings through the adoption of the best practices and voluntary consensus standards relating to commercial and residential buildings. It also encourages public-private partnerships, dialogues on innovative policies and programs, and supports investment in research, training and education.

High Performance Building Week was created by a coalition comprised of approximately 200 organisations who together support cost effective policies that advance high performance buildings. ■

EPEE Wants to Ratify Kigali Amendment

The European Partnership for Energy and the Environment (EPEE), representing the refrigeration, air-conditioning and heat pump industry in Europe, welcomes the ratification of the Kigali Amendment by Belgium. EPEE has taken this opportunity to urge the Council Presidency to ratify the Amendment in time for the next meeting of the 40th Open Ended Working Group of the Parties to the Montreal Protocol taking place in Vienna from 11th July.

"The EU has a unique opportunity to show global leadership in reducing HFC emissions. In order to send a strong signal to countries around the world who have not yet ratified the Kigali Amendment, we urge the Council Presidency to ratify it as a matter of priority," said Andrea Voigt, Director General of EPEE. Belgium ratified the Amendment on 17th June, becoming the 38th country to do so globally and the 11th EU Member State to sign the

agreement. In July 2017, the Council of the EU adopted a decision to conclude the Kigali Amendment on behalf of the EU. Subsequent ratification by several EU Member States in November 2017 triggered the entry into force of the Amendment, as the condition for at least 20 parties to the Montreal Protocol to ratify it was fulfilled. Therefore, the Amendment will take effect on 1 January 2019.

EPEE has been working closely with EU and national decision-makers, industry, end-users and schools to both raise awareness and provide guidance for the successful implementation of the EU F-gas Regulation that will go a long way to meet the requirements of the Kigali Amendment in the EU. Thanks to its innovative EU Gapometer, EPEE has identified the main challenges to achieve the phase-down goals and the concrete actions needed to tackle those challenges. ■

ENGIE Refrigeration Acquires CO₂ High Temp Heat Pumps

ENGIE Refrigeration, the refrigeration specialist from Lindau on Lake Constance, acquired the CO₂ high temperature heat pump activities from the insolvency assets of Hafner-Muschler Kälte- und Klimatechnik. This includes all patents as well as rights to all trademarks and names.

The activities previously performed for Dürer thermea GmbH at the Ottendorf-Okrilla site in Dresden comprise the construction, production, sale and servicing of CO₂-based heat pumps and compressed-air refrigeration dryers. All employees will be kept on and integrated into the ENGIE Refrigeration organisation. They will become a new branch of ENGIE Refrigeration. With this acquisition, ENGIE Refrigeration is expanding its products and services portfolio in the fields of high temperature heat pumps and drying technology with CO₂ technology and further strengthening its position in the field of natural refrigerants. By using the R744 refrigerant, it is possible to achieve temperatures of up to 110 degrees celsius. This opens up applications in the fields of



heating, heat supply in communal and industrial heating networks, and drying technology. The machines that have already been sold under the thermea brand around the world will be looked after by the international ENGIE Refrigeration service network in future.

ENGIE Refrigeration GmbH specialises in products, solutions and services for economical and energy-efficient refrigeration and heat recovery. "The high temperature heat pumps are an excellent addition to our existing product and service portfolio. By using CO₂, we will also be creating a strong starting point for further growth. Hafner-Mutschler's high temperature heat pumps therefore fit perfectly into the ENGIE Refrigeration business strategy", said Jochen Hornung, CEO of ENGIE Refrigeration. ■



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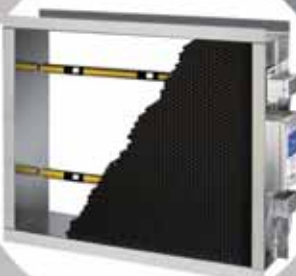
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US States Sue EPA for Climate Change Rule

A group of US states led by New York sued the Environmental Protection Agency (EPA), accusing Administrator Scott Pruitt of trying to illegally roll back limits on the use of climate change pollutants known as hydrofluorocarbons. Eleven states and the District of Columbia said Pruitt violated the federal Clean Air Act on April 27 by issuing guidance that they said effectively rescinded regulations adopted in 2015 under the Obama administration. New York Attorney General Barbara Underwood accused the EPA under President Donald Trump of trying to gut critical climate protection rules through the backdoor by revoking the 2015 limits rather than going through a public review process.

The states petitioned the US Circuit Court of Appeals in Washington, DC to throw out Pruitt's decision. An EPA spokeswoman said the agency does not discuss pending litigation. Hydrofluorocarbons, or HFCs, are often used in air conditioning, refrigerants, aerosols and foam-blowing. The EPA had in 2015 estimated that limiting the pollutants' use could by 2020 reduce annual greenhouse gas emissions by 26 million to 31 million metric tons.

Underwood said 30 million metric tons was enough to power 3.2 million homes. She also noted that the DC Circuit last August upheld EPA authority to declare that HFCs were not safe substitutes for ozone-depleting substances, though it refused to require manufacturers that had replaced such substances with HFCs - when HFCs were thought safe - to switch to something else. In the April 27 guidance, the EPA said revoking the 2015 limits would dispel confusion and provide regulatory certainty for users. California, Delaware, Illinois, Massachusetts, Minnesota, New Jersey, Oregon, Pennsylvania, Vermont, Washington and New York are among many Democratic-led or leaning states that have filed lawsuits challenging a long list of Trump administration policies. ■

Munters Acquires Humi-Tech Services

Munters acquires Humi-Tech Services, specialist within the field of installation, commissioning, service and maintenance of humidifiers in the United Kingdom. Humi-Tech Services is located in Kent and has over 19 years' experience in offering humidification services to its customers. It covers all of the UK with its broad experience of services related to humidification systems. Humi-Tech Services will add further competence to Munters Global Services, already well established for 60 years, in the UK air treatment business. Humi-Tech Services has seven employees and a turnover in the region of 14 million SEK in FY2017. "The acquisition will expand our competencies related to humidification

and enable us to grow our ability to support our customers with new service offerings. It is part of Munters Global Services strategy to grow its footprint and competence. We are very happy to broaden our service portfolio by the acquisition of Humi-Tech Services Ltd." says Sébastien Leichtnam, President Munters Global Services.

"We are extremely pleased to become part of the Munters Group. This will enable Humi-Tech Services to serve our clients in a more efficient and comprehensive way. We strongly believe that Munters; as a global leader in energy efficient, sustainable air treatment and climate solutions will perfectly complement Humi-Tech Services Ltd. Offering," says Richard Johnson and Colin Outram, Humi-Tech Services Ltd. ■

LU-VE Group Lands in USA

LU-VE announces the acquisition of the US corporation Zyklus Heat Transfer, active in the manufacturing and commercialisation of heat exchanger coils. LU-VE, whose shares were admitted to trading on the Italian stock exchange in June 2017, is the holding company of LU-VE Group, one of the main European producers of heat exchangers and ventilated products for the refrigeration, air conditioning and industrial process cooling markets, with production facilities in Europe, Russia, China, and India.

Zyklus specialises in manufacturing heat exchangers for commercial refrigeration, refrigerated transport and air conditioning. It has inherited a long tradition in this sector and is deeply-rooted in its territory, with a client base of prime importance. The acquisition allows LU-VE Group to make use of an existing production facility in the USA as a platform to expand its own business in the North American markets, through the strengthening of the commercial, technical and production structure of Zyklus. At present, there are no existing commercial relationships between Zyklus and LU-VE



Group.

LU-VE Group entered into binding agreements and simultaneously executed closing, thus, acquiring the whole share capital of Zyklus from the former sole shareholder and President, Zachary Riddlesperger, who will continue in the company as Vice-President Operations.

The President of LU-VE Iginio Liberali said "Zyklus's acquisition is another important step in the strategy of internationalisation of the Group. LU-VE is now present in all the most important countries of the world; the US market is the first market in the world for refrigeration and air conditioning. Our 'glocal' growth strategy has led us to invest at international level, to satisfy the requests of different local markets: the acquisition of Spirotech in India in 2016, creating a second facility in Poland, which is currently under construction, and the doubling of the manufacturing surface in China, which will be completed by early 2019." ■



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Mahindra-TERI Centre of Excellence to Enable Energy Efficiency in Realty



Mahindra Lifespace Developers and The Energy and Resources Institute (TERI) launched the first-ever Centre of Excellence (CoE) to boost energy-efficient real estate in India. Energy-efficient building stock in India stands at less than 5 per cent today; the CoE will leverage state-of-the-art research techniques, tools and performance measurement solutions to boost the development of green buildings in India. This joint research initiative will focus on developing open-source and science-based solutions for India's real estate sector.

The CoE will aim at developing a robust and coherent database for market-ready, scalable and energy-efficient materials and technologies. It will also work towards preparing policy briefs for central and state ministries to promote green development that can transform India's housing industry and thereby, help reduce the country's carbon footprint. Research output will be validated on the field prior to dissemination of databases, guidelines and standards to the real estate and building materials industry. The research output, which will be available in the public domain, will aim at wider adoption of its recommendations by developers, architects and individual home owners. ■

Tesco & Carrefour to Create Long-Term Strategic Alliance

Tesco and Carrefour are announcing their intention to enter into a long-term, strategic alliance. The alliance will cover the strategic relationship with global suppliers, the joint purchasing of own brand products and goods not for resale. It will be governed by a three-year operational framework.

The alliance will enable both companies to improve the quality and choice of products available to their customers, at even lower prices, thereby, enhancing their competitiveness. This agreement will also allow both companies to strengthen their relationships with their suppliers and create significant opportunities for those suppliers. Each company will continue to work with supplier partners at a local and national level. It is anticipated that the alliance will be formally agreed within the next two months. Following formal agreement, both parties will start to work towards realising the benefits outlined above.

Dave Lewis, Tesco Group Chief Executive, said, "I am delighted to be entering into a strategic alliance with



Carrefour. By working together and making the most of our collective product expertise and sourcing capability, we will be able to serve our customers even better, further improving choice, quality and value."

Alexandre Bompard, Chairman and CEO of Carrefour Group, said, "This strategic alliance between Carrefour and Tesco is a major agreement as it combines the purchasing expertise of two world leaders, complementary in their geographies with common strategies. This agreement is a great opportunity to develop our two brands at the service of our customers. This international alliance further strengthens Carrefour allowing it to reach a key milestone in the implementation of its strategy." ■

Greece Joins AREA

AREA is proud to announce that Hellas Union Fgas (Hufgas), the Greek Association of Certified and Licensed Engineers and Technicians of Refrigeration and Air Conditioning Systems, became members in Vienna. Founded in December with 30 members, the association was officially recognised by the Greek authorities three months later and now counts 220 members from all 13 regions of Greece.

The association's main purposes lie in the identification of issues for the sector, the provision of support to its members and the protection of the environment. It is notably very active on training.

Thanes Biris, President of the Greek Association, said, "We in Hellas Union Fgas, are a new and fast-growing association, which gives a lot of interest, and of course efforts in training, certification and whatever is needed in our sector for the technicians. I have always



wanted to be in touch with the centre of decisions in Europe and after discussing with my dear friend Marco Buoni, we have decided as Hufgas board to join AREA and get involved in working groups, task forces and be in general in close contact with companies and contractors of the HVAC family." Marco Buoni, President of AREA, said, "I am delighted to see Greece back in AREA. Although it is a young association, Hufgas is already well established and recognised and very dynamic. I am sure that the collaboration with AREA will be extremely mutually beneficial." ■

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Danfoss India Bullish to Drive Growth of Industries

Danfoss Industries, a global industry leader in energy efficient technologies has announced its efforts to increase its product and technology offerings in Odisha with the launch of an exclusive authorised solutions center in the city, through Nuex Engineering Services. This launch is part of the Danfoss India's nationwide efforts to drive the growth of energy-efficient solutions for various industries, by increasing its on-ground presence pan India.

Commenting on the entering the Odisha Market, Ravichandran Purushothaman, President, Danfoss India said, "Odisha is a strong market for businesses across sectors, ranging from food and dairy to heavy industries. The market is quite conducive for investments, thanks to the efforts by the Government of Odisha that have improved the ease of doing business in the State. This has

motivated us to enter the market with the aim of 'Engineering Tomorrow's Odisha' in a sustainable manner, with our energy-efficient products and solutions for the State's thriving industries."

In Odisha, Danfoss is focused on the food infrastructure across various food parks and farm lands by improving the levels of safety and automation in cold rooms and cold storages of the region, to help minimise food loss and double farmer's income. Furthermore, increasing energy efficiency and sustainability across metal, mining and other heavy industries is another core focus area for the company in the region.

P L Palaniswamy, Director - Sales, Danfoss India said, "By partnering with Nuex Engineering Services, we are confident that Danfoss will be able to penetrate the market and address the needs of the region from an energy-

efficiency point of view. Our aim is to enable companies to increase their performance and efficiency in a sustainable manner; the key to development, in our opinion, should always take place while keeping in mind the future generations."

Through this Solutions Centre, Danfoss India will deliver faster access to Danfoss technologies and solutions which can be customized to the needs of industries in the region. Danfoss is already engaged with various stakeholders in Heavy Industries, HVAC, Cold Chain & infrastructure in the region.

With industrialization driving the emergence of newer metropolitans in Odisha such as Cuttack, Rourkela, Sambalpur, Berhampur and more, Danfoss also aims to play an active role in improving the quality of life in these cities with energy efficient technologies that help in making these cities more sustainable and livable. ■

Star Refrigeration Helps Ice Co Storage & Logistics Repair Cold Store

Star Refrigeration's Leeds branch has successfully replaced an unused cold store plant for The Ice Co Storage and Logistics in Newark in order to be leased to a third party. The Ice Co Storage and Logistics site had originally belonged to the ice manufacturing branch of the business, but due to expansion at other sites and a streamline of production, the site had become unused. Looking to lease the plant to a third party for refrigeration, storage and distribution purposes, the company invited Star to assess the costs of making it operational again. Paul Martin, Managing Director from The Ice Co Storage and Logistics said, "We've had a strong relationship with Star over the years, and knew they had the expertise for the job. We saw a business opportunity in our unused cold store, and with the cost-effective and highly-efficient solution provided by Star."

Noting that the original cold store plant operated with a R404A refrigerant and an F-gas, currently being phased down by new regulations, Star concluded that in order to reinstate operations, the plant

would require not only a controls upgrade and a condenser replacement, but also a refrigerant conversion to allow for the operation of the plant in the medium term. These costs would have amounted to roughly the same as replacing the existing common plant with all new facilities and it was agreed that comprehensive replacement represented the best option. The supply, installation and commissioning of the new plant was carried out as a branch contract through Star's Leeds branch. The new plant took the form of two DX R449A condensing unit plants, both of which serve a single ceiling-mounted evaporator within the cold store. Both units operate at 36kW, which represents 65 per cent of the maximum design duty, affording a solution which combines performance with resiliency.

Star took advantage of an existing concrete plinth situated at ground level directly behind the internal evaporators to install the condensing units, while two networks of interconnecting pipework



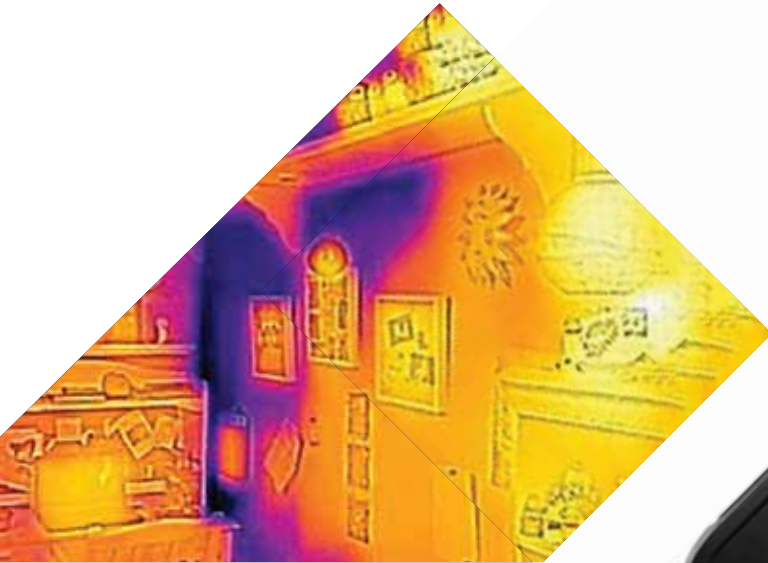
were run up the outside of the building to reach the roof void above the evaporators. This achieved a practical solution which minimised installation time, expense and effort. Star also prioritised energy-efficiency in this project. By incorporating the same electronic expansion valves, EC condenser fan and a skip-defrost function, Star were able to guarantee optimal energy consumption. Furthermore, The Ice Co Storage and Logistics is one of many businesses to benefit from Star's award-winning refrigeration energy management system Ethos, which scooped Refrigeration Product of the Year at the 2018 National ACR & Heat Pump Awards. ■

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Jean S Blackwell Elected to Board of Johnson Controls

The Board of Directors of Johnson Controls International, elected Jean S Blackwell to serve as a Director, effective immediately. Blackwell previously served as the Executive Vice President of Corporate Responsibility and Chief Executive Officer of the Cummins Foundation.

Blackwell joined Cummins in 1997 and has served in various leadership roles including Chief Financial Officer, General Counsel and Vice President of Human Resources. Prior to joining Cummins, she was a partner with the law firm of Bose McKinney and Evans in Indianapolis. She also previously served as Budget Director for the State of Indiana. "I am excited to have Jean join our Board of Directors as she will provide



Jean S Blackwell

strong leadership because of her broad experience leading global functions at Cummins and her role serving on the boards of Celanese Corporation and Ingevity Corporation," said George Oliver, Chairman and CEO of Johnson Controls. Blackwell received her bachelor's degree in economics from the College of William and Mary and her Juris Doctorate from the University of Michigan.

Blackwell is the third director to join the board in the last six months. Simone Menne, former Chief Financial Officer of Boehringer Ingelheim GmbH and Gretchen R Haggerty, former Executive Vice President & Chief Financial Officer, United States Steel Corporation have also been elected to the Johnson Controls Board of Directors. ■

NREL's Sheila Hayter Named as President of ASHRAE

Sheila Hayter, Group Manager with the US Department of Energy's National Renewable Energy Laboratory (NREL), was named recently as President of the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) during the industry group's annual conference in Houston, Texas.

As part of her inaugural presidential address, Hayter revealed her term's theme will be 'Building Our New Energy Future.' It focuses on the important role buildings playing in our energy future as the traditional electrical grid continues to evolve towards a smart grid with advances in renewable energy. Hayter joined NREL in 1992 and has led a team of experts in the Integrated Applications Center,



Sheila Hayter

supporting international, federal, state, and local entities with the goal of significantly reducing non-renewable energy consumption through optimised use of energy efficiency strategies and renewable energy technologies, as well as addressing challenges to increase resiliency in the built environment.

Hayter is a registered professional engineer. She earned a master's degree in mechanical engineering from the University of Colorado and a bachelor's degree in mechanical engineering from Kansas State University. For Hayter, her roots in ASHRAE run deep. Her father, Richard Hayter, served as the ASHRAE president from 1995–1996. ■

Aspen Pumps Appoints Kelly Butler as Marketing Director

Aspen Pumps, the global pace setter in design, manufacture and distribution of condensate removal pumps and ACR ancillaries, is delighted to announce the appointment of Kelly Butler as Group Marketing Director. Kelly's appointment underlines Aspen's commitment to push towards the next phase of growth, which has been the cornerstone of Aspen's heritage for over 20 years, either through launches of innovative products, the success of a dynamic sales team or strategically focused business acquisitions.

A key appointment to the Aspen team, Kelly brings with him a wealth of knowledge boasting over 20 years' marketing communications and product management experience within the built environment. A well-known figure within the HVAC



Kelly Butler

sector, before joining Aspen, Kelly was Deputy CEO at BEAMA, the leading trade association representing electrotechnical manufacturers. He was also a member of the senior team at the Energy Saving Trust responsible for trade marketing relationships and home energy marketing.

"We are delighted to welcome Kelly to the management team at Aspen Pumps Group," said Adrian Thompson, CEO of Aspen Pumps. "Over two decades we have continued our global expansion through acquisitions, investment in sales resource and product innovation. Overall, the Group has delivered record growth; this is all down to the hard work and dedication of the Aspen team. The appointment of Kelly will now help us move forward as we enter our next phase of growth." ■

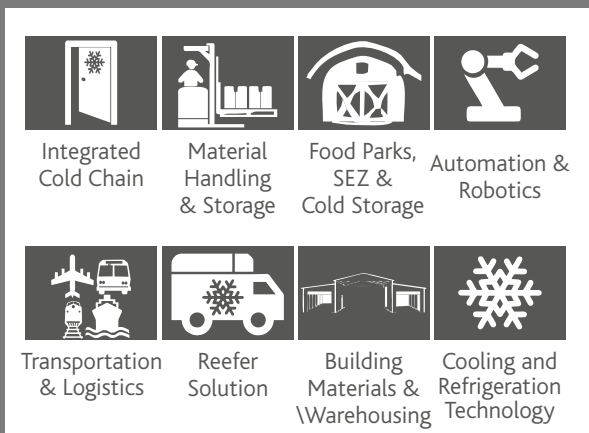


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USGBC Announces 2018 Greenbuild Leadership Awards in Mexico City

USGBC announced the recipients of the 2018 Greenbuild Leadership Awards. César Ulises Treviño, Carrier and FINSA will be honoured at the inaugural Greenbuild Mexico conference in Mexico City during the closing plenary on June 21. The Leadership Awards recognise outstanding individuals and organisations at the forefront of the green building movement.

"Treviño, Carrier and Finsa have helped paved the way for green building across Mexico and their work inspires others to discover the power of green building in helping to improve lives and support local economies," said Mahesh Ramanujam, President and CEO, USGBC and GBCI. "Around the world, Greenbuild is recognising extraordinary leaders, like them, who are driving the green building movement forward in their markets. Their work and the work of others across the country is helping to position Latin America as a new hub for green activity."

This year's Leadership Award recipients have made significant strides supporting the transformation of the built environment in Mexico:

César Ulises Treviño, CEO of Bioconstrucción & Energía Alternativa (BEA), is the founder and former CEO of the original Mexico Green Building Council (GBC). Treviño was also the first

Latin American representative on the World GBC Board of Directors and first LEED Fellow in Latin America. His company has more than 50 sustainable projects that have been certified through programs, including LEED, EDGE and WELL.

Carrier was the first member of USGBC and a founding member of SUMe. With four LEED Gold projects, Carrier has more than 1.5 million gross square feet of certified space in Mexico. Carrier is one of the few product manufacturers in Mexico to produce in a LEED-certified factory that is part of a LEED building.

FINSA has been part of the LEED Volume program since 2016 and has 17 certified projects in Mexico, making them one of the largest national developers to adopt LEED. The company is working to design new LEED-certified building inventory to reduce over 50 per cent of total water consumption, reduce energy between 20 and 30 per cent and use lower chemical contaminants to improve indoor air quality.

Mexico's green building activity has been growing, and in 2017, the country made USGBC's list of Top 10 Countries and Regions for LEED for the first time. Currently, there are nearly 1,000 LEED-certified projects in the country, totaling 31 million square feet of space. ■



CoolSys Earns Accelerate America Award

CoolSys, the parent of market-leading refrigeration and HVAC companies nationwide, announced it is the recipient of the Accelerate America Award for its role in bringing climate-friendly solutions to the HVACR sector in North America. Presented as part of the recent Atmosphere America conference, the Accelerate America Award recognises those who have excelled in driving natural refrigerants adoption in North America.

"We are proud to be celebrated for our leading role in promoting the use of natural refrigerants in the food retail industry," says Bryan Beitler, Vice President of Engineering for CoolSys. "It is truly an honour for the CoolSys team to receive the Accelerate America Award for our innovation and hard work." CoolSys received the best contractor award in the food and retail sector for the innovative adoption of natural refrigerants by its Source Refrigeration business. It was one of six companies recognised in the Accelerate

America Awards program, sponsored by shecco, a global market accelerator that focuses on bringing innovative solutions to the HVACR market and organises the annual Atmosphere America conference.

With long-standing relationships with leading grocery retailers as well as market-leaders in many other industries, CoolSys is well-known for driving the current trends toward natural refrigerant options. Beitler accepted the award at an Atmosphere America ceremony and luncheon held at Parkers' Lighthouse Restaurant in Long Beach, California.

"Natural refrigerant-based technologies are disrupting the HVACR industry in North America," said Marc Chasserot, CEO of shecco. "The Accelerate America Awards recognise the companies and people behind this wave of innovation, who are designing, using and promoting functioning technologies in brand new ways to meet exciting new business opportunities." ■



From Depressed to a Sunrise Sector

The Food Processing sector has got a boost with investment MoUs worth Rs 1,00,000 crore in last one year alone.



Picture Courtesy: www.pixabay.com

Food Processing sector is all set to become one of the most robust sectors in India, contributing to India's growth. Further, the sector is all set to help doubling farmers' income by 2022. According to the Union Minister for Food Processing Industries Harsimrat Kaur Badal, earlier, food processing sector was totally disorganised and the industry was apprehensive of launching new projects or products and committed projects were being delayed and shelved. Now, the sector has received investment commitments of nearly Rs 1,00,000 crore in last one year alone and out of which investments worth Rs 73,000 crore have started grounding.

"The last government sanctioned 42 mega food parks from year 2008 onwards and six years later when I took over, only two (one of them Patanjali) could get operationalised during 2008 to 2014. I can now proudly say that overall 25 mega food parks would be operationalised by 2018. Out of these 25 food parks, 15 have already been completed so far and 15 more shall be operationalised by 2019," said the minister.

Government is creating a Cold Chain Grid to link every nook and corner of India by its 42 Mega Food Parks, 234 Cold Chain Projects and around 700 projects under PM Kisan Sampada Yojana. With the schemes of the Ministry, more than 33 lakh farmers shall be directly benefited every year. Moreover, the Minister informed, "We are in the process to create a new Financial Institution that will exclusively fund food processing

Glimpse of Investments

- World Food India 2017 successfully created 'Brand India' putting the country on the global food map leading to MoUs for investments worth \$ 14 billion
- FDI inflow between April, 2017 and December, 2017 was USD 822 million
- Projects worth \$ 11 billion are already being grounded by over 30 companies
- Metro Cash & Carry is adding 25 more stores.
- SIAM Makro or CP Wholesale is opening three Big wholesale stores in New Delhi and one store in Noida
- Amazon has opened a total of 67 warehouses in the country so far with 15 stores being opened
- Grofers has invested in setting up of over 10 vegetable processing centers
- Over \$ 1 billion has already been invested by Coca-Cola, Britannia, Cargill, Tilda Hain, Emami, Keventer Agro, Rich Gravis etc

projects and create capacity building in the field of risk assessment and lending to food processing sector. Request for proposal for the institution which will be called Agro Processing Financial Institution, will be out by July, 2018. It will be a Non-Banking Financial Institution and will be largely driven by private sector and government will act as a facilitator. There is a keen interest in the institution by both national and international companies."

Last four years have witnessed 351 per cent mega increase in preservation and processing capacity of 15.94 lakh MT per annum created by the Ministry. Big-time increase of 720 per cent in cold storage capacity. 180 per cent increase in the value of agro produce processed by the projects handled by the Ministry.

Under the new Scheme Pradhan Mantri Kisan SAMPADA Yojana, total of 122 projects have been approved under three schemes viz. Agro Processing Clusters, Backward-Forward Linkage and Unit scheme leveraging an investment of Rs 2,300 crore. This is expected to generate direct and indirect employment of around 3.4 lakh persons. ■

Source: PIB

Heat Pump Market Worth \$ 94.42 Bn by 2023

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



Picture Courtesy: www.grovehvac.com

According to MarketsandMarkets research report 'Heat Pump Market', the market is expected to grow from an estimated \$ 54.34 billion in 2018 to \$ 94.42 billion by 2023, at a CAGR of 11.68 per cent, during the forecast period.

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

Up to 10 kW segment is expected to be the largest Heat Pump Market, by rated capacity, in 2018

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

The residential end-user segment is expected to generate significant demand for heat pumps during the forecast period.

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

environment. Governments are relying on smart buildings, which ensure a lower carbon footprint, 40 per cent reduction in the usage of water, and less electricity consumption. Thus, developers and owners of buildings are trying to meet energy-efficiency guidelines using equipment such as heat pumps.

Asia Pacific: The key market for heat pumps during the forecast period

In this report, the heat pump market has been analysed concerning four regions, namely, Asia Pacific, Europe, North America, and Rest of the World

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

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

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Improving Energy Efficiency in Cooling Tower

Maintenance and water treatment are the most important factors affecting the life and energy efficient operation of an evaporative cooling equipment. At the same time, they are also the most neglected regimens of cooling tower operation with cooling towers generally the most neglected component in the mechanical system.



Photo Credit: www.pixabay.com/

Before getting into the details of improvement in energy efficiency, one must properly understand about what exactly a cooling tower is, its function and key components involved in its functioning. It is also necessary to know certain fundamental terminologies related with functionalities.

The water then gets distributed by cooling tower nozzles to the wet deck. At the same time, air is being drawn through

the air-inlet louvers forcing water to evaporate. Evaporation causes the heat to be removed from the make-up water.

- A cooling tower is an enclosed tower like structure through which atmospheric air circulates to cool large quantities of warm water by direct contact.
- Cooling towers are a very important part of many plants.
- Cooling tower is to reject heat into the

atmosphere.

- Removing low-grade heat from cooling water.
- The make-up water source is used.

The principle of operation of a cooling tower fill is to put as much water surface area in contact with as much air as possible for the longest amount of time possible. Film fills allow the water to form thin flowing sheets to expose as much water surface area as possible to the interacting flow.

Drift eliminators are designed to capture large water droplets caught in the cooling tower air stream. The eliminators prevent the water droplets and mist from escaping the cooling tower.

'Approach' is the difference between the cooling tower outlet cold water temperature and ambient wet bulb temperature. Although both range and approach should be monitored, the 'Approach' is a better indicator of cooling tower performance.

Tower fans oscillate on a base stand and distribute air circulation at a 90-degree angle. This angle combined with the height of the unit gives the tower fan its wider area of cool air circulation. The impeller blades move air through the cylindrical column and then out of the vents of the tower fan. A closed-circuit cooling tower or dry cooling tower involves no contact between the air and the fluid being cooled. This tower has two separate fluid circuits, one in which the fluid is recirculated on the outside of the second circuit, which is a bundle of tubes through which the hot water is flowing.

Air intake louvers also prevent sunlight from entering into the cooling tower. Preventing sunlight from reaching the basin is critical to prevent algae growth. They also lower the amount of splash out of a cooling tower which preserves water.

Cooling tower bleed-off or blowdown is the flushing of a portion of high mineral concentration cooling tower system water down the drain while simultaneously replacing it with fresh water. This process dilutes the system water mineral concentrations that steadily increase due to water evaporation.

There are mainly two types of cooling towers:

Cooling towers may either use the evaporation of water to remove process heat and cool the working fluid to near the wet-bulb air temperature or, in the case of closed circuit dry cooling towers, rely solely on air to cool the working fluid to near the dry-bulb air temperature.

A nominal cooling tower ton is defined as the capability to cool 3 GPM (0.19 lps) of water from a 95°F (35.0°C) entering water temperature to an 85°F (29.4°C) leaving water temperature at a 78°F (25.6°C) entering wet-bulb temperature.

Cooling towers are rated in terms of approach and range, where the approach is the difference in temperature between the cooled water temperature and the entering air wet bulb temperature - twb - temperature. The range is the temperature difference between the water inlet and water exit. A key parameter used to evaluate cooling tower operation is 'cycle of concentration' (sometimes referred to as cycle or concentration ratio). This is determined by calculating the ratio of the concentration of dissolved solids in the blowdown water compared to the make-up water. Now, that the cooling season is fully underway, cooling towers are hard at work. Is it necessary to show a cooling tower the TLC it needs to be running at its peak performance efficiently? The Cooling Technology Institute made up a great Powerpoint presentation that is the basis for this post.

Maintenance and water treatment are the most important factors affecting the life and energy efficient operation of evaporative cooling equipment. They are also the most neglected regimens of cooling tower

operation with cooling towers generally the most neglected component in the mechanical system. Why are these important steps often the most ignored?

- Most cooling equipment is remotely located and difficult to access. Limited maintenance resources such as staff, training, or budgets make it a problem. Staff do not realise its importance. Here are some basic maintenance practices for the varying types of cooling systems: If an operator is using a circulating water system, cleaning and flushing the system monthly is key. This prevents build-up of any solids in the system which can clog lines or make a breeding hot spot for bio growth. It is essential to inspect and repair corrosion because the longer wait can become a losing battle. It is necessary to check all the seals, because a leak can lead to huge losses of water and chemicals, racking up the bill.
- For fan driven systems, it is essential to make sure to keep the fan system in top operating condition. This means someone should be checking daily for any unusual vibrations or sounds, as this could mean there is a problem. The fan should be cleaned quarterly of heavy debris such as trash, bird droppings, or scale. there is a need to check for loose tighteners, missing balance washers, structural integrity and repair or replace any corroded hardware. Making sure that the motor is operating smoothly is also the key. Check to see that the motor is lubricated properly and is being cooled so it does not overheat, which can cause serious damage. Routine

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Comparing 3 fill media: film fill more efficient

	Splash Fill	Film Fill	Low Clog Film Fill
Possible L/G Ratio	1.1 – 1.5	1.5 – 2.0	1.4 – 1.8
Effective Heat Exchange Area	30 – 45 m ² /m ³	150 m ² /m ³	85 - 100 m ² /m ³
Fill Height Required	5 – 10 m	1.2 – 1.5 m	1.5 – 1.8 m
Pumping Head Requirement	9 – 12 m	5 – 8 m	6 – 9 m
Quantity of Air Required	High	Much Low	Low

maintenance of the motor will help to ensure it has a long and useful life.

Finally, it is important to make sure to keep up with a water treatment plan. Water treatment plans can be the difference in having to replace something or not. When air and water contents enter the tower, they can build up, creating possible problems. Microbes can form, producing bio-growth that is unwanted, or corrosion could occur, which means replacing the affected parts. Both can add up to an expensive fix compared to the cost to treat the water. Following factors can seriously affect the efficiency of the cooling tower:

Selecting a Cooling Tower

i) Capacity

- Heat dissipation (kCal/hour)
- Circulated flow rate (m³/hr)
- Other factors.

ii) Range

- Range determined by process and not by system approach
 - Closer to the wet bulb temperature
- Bigger size cooling tower
- More expensive.

iii) Heat Load

- Determined by process
- Required cooling is controlled by the desired operating temperature
- High heat load = large size and cost of cooling tower.

iv) Wet bulb temperature – considerations

- Water is cooled to temp higher

than wet bulb temp

- Conditions at tower site
- Not to exceed 5 per cent of design wet bulb temp
- Is wet bulb temp specified as ambient (preferred) or inlet
- Can tower deal with increased wet bulb temp
- Cold water to exchange heat.

v) Relationship range, flow and heat load

- Range increases with increased
- Amount circulated water (flow)
- Heat load.

vi) Causes of range increase

- Inlet water temperature increases
- Exit water temperature decreases
- Consequence = larger tower.

vii) Relationship Approach and Wet bulb temperature

- If approach stays the same (e.g. 4.45°C)
- Higher wet bulb temperature (26.67°C) more heat picked up (15.5 kCal/kg air) smaller tower needed
- Lower wet bulb temperature (21.11 °C) less heat picked up (12.1 kCal/kg air) larger tower needed.

Fill media

- Hot water distributed over fill media and cools down through evaporation
- Fill media impacts electricity use
- Efficiently designed fill media reduces

pumping costs

- Fill media influences heat exchange: surface area, duration of contact, turbulence.

Pumps and Water Distribution

Optimise cooling water treatment

1. Increase cycles of concentration (COC) by cooling water treatment helps reduce make up water
2. Indirect electricity savings
3. Install drift eliminators
4. Reduce drift loss from 0.02 per cent to only 0.003 – 0.001 per cent.

Fans and motors

- Fans must overcome system resistance, pressure loss: impacts electricity use
- Fan efficiency depends on blade profile
- Replace metallic fans with FBR blades (20-30 per cent savings)
- Use blades with aerodynamic profile (85-92 per cent fan efficiency).

Controls

- Wherever possible use of VFD will add to efficiency.
- Use of PLC synchronised with RTC and Load demand will lead to drastic improvement in performance, operational life, reduced maintenance and huge energy saving. The most important thing to take away from this is that it is better to be proactive than reactive. Hence, it is necessary to adopt not only proactive maintenance but also condition monitoring approach. ■

Dr. OmPrakash G. Kulkarni

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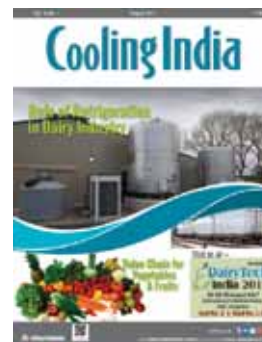
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Trane systems enable Pritech Park achieve 'LEED Platinum' certification

Bangalore's Pritech Park developers had challenging expectations from HVAC systems manufacturers in terms of energy efficiency, IAQ and reliability. Trane delivers the solution to maximise comfort, efficiency and savings.



Trane has deployed high efficiency heating, ventilation and air conditioning (HVAC) systems at state-of-the-art Pritech Park – SEZ Bangalore, which is a LEED Platinum certified facility. Pritech Park is an approved and notified multi-tenant IT/ITES/hardware SEZ and home to many renowned international business or IT companies. Pritech Park SEZ has been established by RGA Software Systems, which was incorporated in the year 2000 with an aim to develop infrastructure facilities for the IT Industry.

Challenge

The Pritech Park developers had challenging expectations from HVAC systems manufacturers in terms of energy efficiency, indoor air quality and reliability. With a diverse set of tenants and varied work hours, they sought to accommodate the individual comfort needs of the occupants. In addition, they wanted to bring down the operating and service costs.

Solution

Based on a thorough understanding of the infrastructure needs and health, safety and environmental requirements, the

Trane team proposed the best solution to maximise comfort, efficiency and savings. Trane recommended Air Cooled Screw chillers, Centrifugal chillers and Tracer Summit Chiller Plant Manager at Pritech Park – SEZ. All chillers were covered under the Trane Select service contracts.

The CenTraVac centrifugal chiller also has the lowest total refrigerant emissions rate in the industry. Ensuring tenant comfort controls with easy-to-navigate touch screens and displays allow RGA engineers to monitor the equipment and make adjustments as necessary. The Tracer Summit Chiller Plant Manager is an intelligent plant management system with specific control strategies to optimise overall chiller plant energy efficiency and reliability while providing predictive maintenance control.

Result

Pritech Park – SEZ is benefiting from maximum system efficiency, simplified maintenance, lower overall operating costs, and improved indoor comfort levels for occupants with commensurate health and productivity benefits, which would result in fast payback and return on investment.

Systems deployed in Phase 1 and 2 have been interconnected and either of the plant managers can take care of the building loads. Since the highly efficient Centravac chillers run most of the time, the total energy cost for the buildings has been low.

To achieve LEED certification, the project met strict requirements regarding sustainable sites, water efficiency and atmosphere, materials and resources, indoor environment quality & innovation in design. Trane has played a significant role in creating Pritech Park as a high performance green building that is healthy, productive place to work; is less costly to operate and maintain; and has reduced environmental impact. Pritech Park has been awarded 'LEED Platinum' core and Shell by IGBC. ■

(Source: Trane)

Performance of Cooling Towers in Building Air Conditioning

The performance parameters like range, approach, cooling capacity, evaporation loss liquid to gas ratio (L/G) have been studied when the cooling tower is operated at full load and part load under the same water flow rates.



Photo Credit: www.betazona.com

Large air-conditioning plant used for production of thermal comfort in commercial building and some other industrial applications produce a large quantity of waste heat in the form of hot water. In the present scenario, in most of the places, the water supply is limited and thermal pollution is also a serious concern. Considering the recent increase of interest in analysing these problems and

solving them for the well being of the environment, the attempt was to deal with the technology, applications of cooling towers. The factors affecting the performance of cooling towers like environmental conditions, cooling water quality needed to be optimised. The performance parameters like range, approach, cooling capacity, evaporation loss liquid to gas ratio (L/G) have been

studied when the cooling tower is operated at full load and part load under the same water flow rates.

Introduction

In vapour compression based large conventional air conditioner, one of the main parts is condenser, which cools the refrigerant. When cooling the refrigerant, the cold water becomes the hot water. The



hot water temperature is reduced by cooling towers. When hot water enters into the cooling tower and sprayed by nozzles, hot water is converted into cold water. The effective cooling of water depends upon the dry bulb temperature and wet bulb temperature, size, height of the cooling tower and velocity of air. A cooling tower is an enclosed device for the evaporative cooling of water by contact with the air. Cooling tower is a heat rejection device. Common application besides to air-conditioning includes cooling the circulating water used in oil refineries, petrochemical, and other chemical plants, thermal power stations and HVAC system for cooling buildings. The efficiency and effectiveness of a cooling tower depends on number of parameter like inlet air angle, inlet and outlet temperature of air and water, fill materials, fan speed etc.

Over a last decade, great strides have been made in improving the performance of conventional cooling towers. Heat is dissipated from the surface of a body of water by convection, evaporation and radiation. The driving force is difference in

enthalpy rather than in temperature. The water temperature tends to approach the wet bulb temperature rather than the dry bulb temperature of air. This offers an inherent advantage in making it possible to cool the water to a temperature lower than the dry bulb temperature. This cooling is accomplished by a combination of the sensible heat transfer and evaporation of a small proportion of water. A mechanical draft cooling tower is used to increase the cooling capacity. For the increasing of L/G ratio, the heat transfer rate between liquid and gas also needs to be increased. The ultimate aim is to improve the performance analysis of cooling tower by enhancing efficiency of cooling tower.

Working of Cooling Tower

Cooling towers are a special type of heat exchanger that allows water and air to come in contact with each other to lower the temperature of the hot water. During this process, small volumes of water evaporate, lowering the temperature of the water that is being circulated throughout the cooling tower. In a short summary, a

cooling tower cools down water that gets over heated by industrial equipment and processes. The hot water is usually caused by air conditioning condensers or other industrial processes. That water is pumped through pipes directly into the cooling tower. Cooling tower nozzles are used to spray the water onto to the 'fill media', which slows the water flow down and exposes the maximum amount of water surface area possible for the best air-water contact. The water is exposed to air as it flows throughout the cooling tower. The air is being pulled by a motor-driven electric 'cooling tower fan'. When the air and water come together, a small volume of water evaporates, creating an action of cooling. The colder water gets pumped back to the process or equipment that absorbs heat or the condenser. It repeats the loop over and over again to constantly cool down the heated equipment or condensers.

Types of Cooling Tower

Cooling towers mainly divided into two categories according to need of power requirement for its operation as follows:

Natural draft cooling tower

The natural draft or hyperbolic cooling tower makes use of the difference in temperature between the ambient air and the hotter air inside the tower as hot air moves upwards through the tower (because hot air rises) and fresh cool air is drawn into the tower through an air inlet at the bottom as shown in Fig.1.

Mechanical draft cooling tower

Mechanical draft towers have large fans to force or draw air through circulated

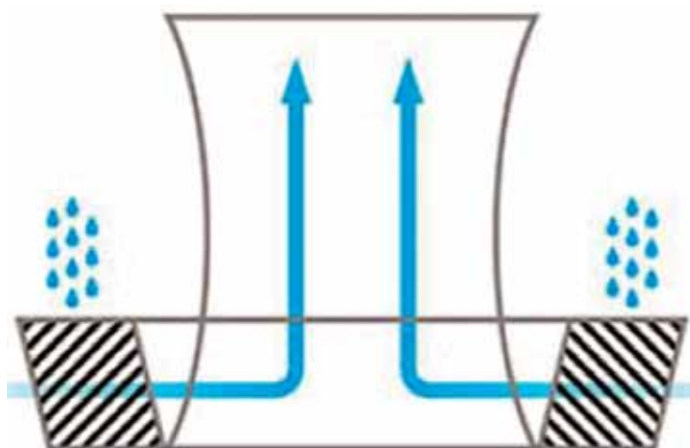


Figure 1: Natural draft cooling tower

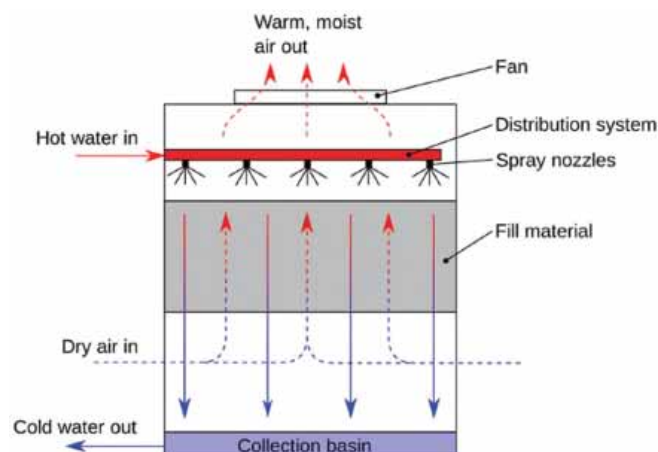


Figure 2: Mechanical draft cooling tower

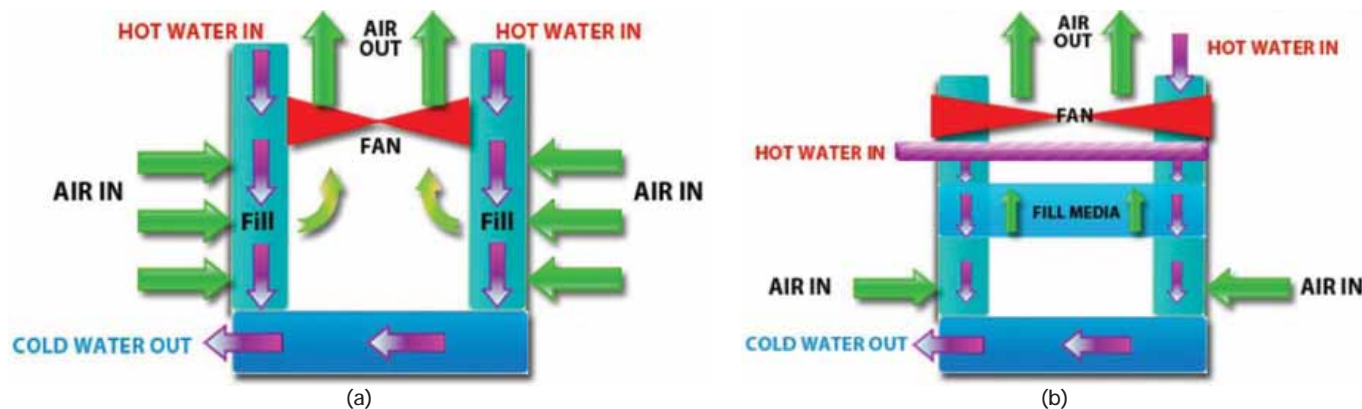


Figure 3: (a) Cross flow (b) Counter flow cooling tower.

water as shown in Figure 2. The water falls downwards over fill surfaces, which help increase the contact time between the water and the air. This helps maximise heat transfer between the two. Cooling rates of various parameters such as fan mechanical draft towers depend on diameter and speed of operation, fills for system resistance etc.

Cross flow and counter flow design

In cross flow cooling tower systems (Figure 3a) the water vertically flows through the fill media while the air horizontally flows across the falling water. That is why they call it 'cross flow', because the air and water cross paths or flows. Because of the crossing of flows, the air doesn't need to pass through the distribution system. This permits the use of hot water flow via gravity and distribution basins on the top of the tower right above the fill media. The basins are a standard of cross flow cooling towers and are applied

on all units.

In counter flow cooling tower system processes (Figure 3b), the air vertically flows upwards, counter to the water flow in the fill media. Due to the air flowing vertically, it is not possible to use the basin's gravity flow like in cross flow towers. As a substitute, these towers use pressurised spray systems, usually pipe-type, to spray the water on top of the fill media. The pipes and cooling tower nozzles are usually spread farther apart so they will not restrict any air flow.

A brief comparison between counter flow and cross flow cooling tower is tabulated below as table 1.

Performance Parameters for Cooling Towers

A number of parameters describe the performance of a cooling tower.

- **Water/Air Ratio (m_w/m_a)** is the mass ratio of water (liquid) flowing through

the tower to the air (Gas) L/G flow.

- **Approach** is the difference between the temperature of the water leaving the tower and the wet bulb temperature of the entering air.
- **Range** is the temperature difference between the hot water entering the cooling tower and the cold water leaving. The range is virtually identical with the condenser rise.
- **Evaporation Rate** is the fraction of the circulating water that is evaporated in the cooling process.
- **Drift** is water that is carried away from the tower in the form of droplets with the air discharged from the tower.
- **Recirculation** is warm, moist air discharged from the tower that mixes with the incoming air and re-enters the tower.

Performance Analysis

Figure 4 shows effect of fan speed on the performance of a cooling tower in case of cold water temperature requirement with various wet bulb temperature of incoming air. By providing the fan speed, cold water requirement can be lowered at minimum wet bulb temperature of incoming air.

Figure 5 shows amelioration in heat transfer by providing fill in the cooling tower. Heat transfer from evaporated water to air can be increased by providing filler of good quality material in cooling tower. The efficiency of cooling tower with fill material is high as compared to the efficiency of cooling tower without fill material. Fill material is used to increase the water and air contact inside the cooling

Table 1. Comparison between counter flow and cross flow cooling tower

	Counter flow	Cross flow
Water Distribution	Lower HP pumping head	Upto 50% higher riser
Recirculation	No intendancy	Reduction in performance
Capacity	50% more with cellular fill	Too costly for film fill
Icing	Controllable with Aux Piping	Louver icing prevalent
	Reverse fan more effective	Too high a profile to be heated
Future Expansion	Fill depth easily increased	no inexpensive capability
Maintenance	Easier access to components	Interior height dangerous
	Cold water basin open	cannot clean the cold water basin
Fan Horse Power (HP)	Less usually required	More HP for same work
First Cost	Larger capacity towers. less	Costs more for same work

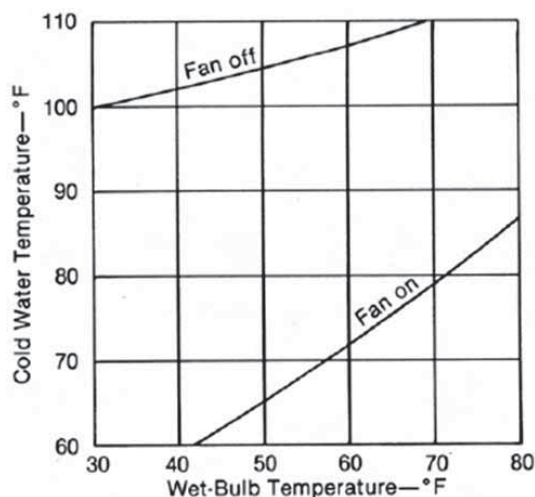


Figure 4: Effect of fan speed on requirement of cooling water temp at various WBT of air.

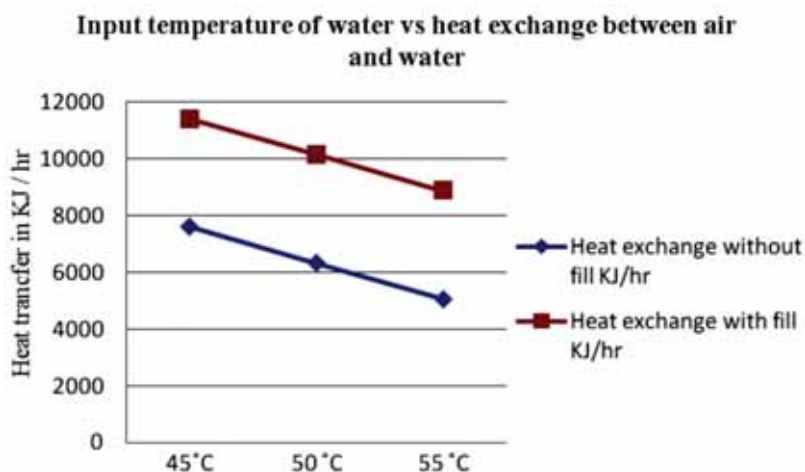


Figure 5: Effect of fill on heat transfer rate in cooling tower.

tower. So, the heat loss by water is also high as compared to the cooling tower without fill material. The evaporation loss

of cooling tower with fill material is little high, because the water and air contact time is high. Even though losses are

generated in the cooling tower, the cooling is achieved due to heat transfer between air and water. ■

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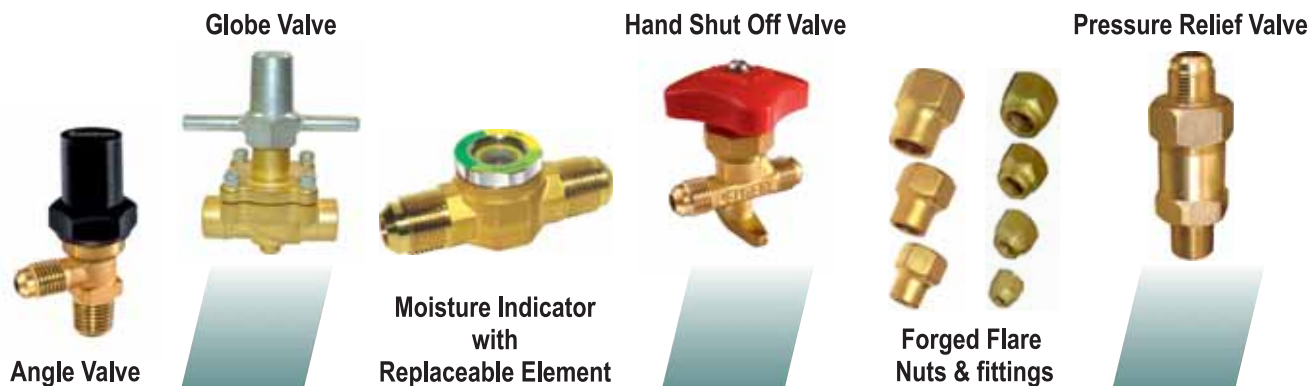
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Testing & Commissioning of HVAC Systems

Building Management System is used to control and monitor complex HVAC systems as per design intent. It is used to collect data about the performance of the building as well as energy consumption by individual equipment and systems.



Photo Credit: www.advancedcontrolcorp.com

Today, heating, ventilation and air-conditioning (HVAC) systems are becoming one of the key building blocks in modern infrastructure. These systems are found in almost all commercial as well as residential buildings. HVAC systems involve not only a major cost during construction but also contribute to

a large operating cost as the building comes to life. HVAC systems account for a whopping 40-50 per cent of energy consumption of a commercial building.

HVAC systems have also become complex, non-linear and dynamic. These systems are equipped with advanced controls and highly efficient components

to aid in reducing a building's energy efficiency, they require fine-tuning to operate at their highest level of efficiency while providing optimal climate conditions for occupants and contents of commercial spaces. Building Management Systems (BMS) are used to control and monitor complex HVAC systems as per design

intent. They are used to collect data about the performance of the building, as well as energy consumption by individual equipment and systems.

Building owners are challenged with getting financial returns from their investments while providing a building that is energy efficient. Many a times it is observed that HVAC systems and BMS do not work as per design. Chillers, AHUs, pumps, cooling tower, VRF systems do not work as per design efficiencies. VFDs across fans and pumps do not modulate as per desired control logic. Facility team gets regular complaints from end-users for under- or over-cooling and poor indoor air quality. BMS fail to work as per control logic and systems run in manual mode. Owners do not get benefits expected from energy efficient and smart building and eventually no financial returns is achieved on their investments on these systems. Most of the time these issues occur due to improper commissioning and lack of trained facility team to operate the systems.

Commissioning is arguably the most critical aspect of the sustainable development cycle as it ensures that a building is handed over to operate safely, efficiently and in accordance with how the owner intended. Commissioning has come to be recognised as the most important process needed for design, construction and operation and maintenance of HVAC system to realise owners true project intent and establish energy saving and sustainable operation and management of the building system.

Proper commissioning is not just a testing and verification process and must start early in the project and continue until a comprehensive handover to the operations and maintenance team is achieved. Furthermore, one must look beyond simply commissioning individual systems as the complex buildings of today require very careful integration of numerous interdependent systems. This is essential to not only improving the efficiency of buildings and reducing maintenance costs but also overcoming safety issues in the building.



The commissioning process is defined as: "A quality-focused process for enhancing the delivery of a project. The process focuses upon verifying and documenting that all of the commissioned systems and assemblies are planned, designed, installed, tested, operated and maintained to meet the Owner's Project Requirements"

Commissioning ensures building quality by using design review and on-site verification to help maximise energy efficiency, environmental health, and occupant comfort. The process improves indoor air quality by ensuring building components work correctly and that plans are implemented efficiently and effectively. Commissioning also confirms that maintenance plans, O&M manuals, and training procedures are correct and in-place for maintenance staff to follow. It is also a mandatory requirement to hire commissioning authority for achieving Green Certification (USGBC/IGBC) for a project.

The key drivers are energy cost reduction, sustainability, reduced O&M costs, improved efficiency, and occupant health and safety, but these may vary

according to building type and owner.

The commissioning process is complex owing to the interdependence of numerous systems and trades during a time critical point of the project. Commissioning management is a systematic process of managing the overall commissioning of a building from design to handover. Detailed planning and developing and continuously updating realistic commissioning programs are essential components of commissioning management but the success of the process in our view hinges on the expertise and experience of the commissioning management team.

Steps involved in commissioning processes are as follows:

Hire Commissioning Agent (CA): CxA should be part of the project from the early design phases all the way through the end of the project. A commissioning authority or commissioning agent is usually contracted directly to a building owner as an independent representative to ensure unbiased performance of the CxA

Develop Owner's Project Requirement: The OPR defines the expectations, goals, benchmarks, and



success criteria for the project. The CxA typically assists the owner in identifying the facility's requirements regarding such issues as energy efficiency, indoor environment, staff training, and O&M.

Develop Basis of Design: BOD documentation shows how a design meets the operational and performance requirements of a project and its systems. Together, this information tells the story for how the design team has translated the OPR into an actual design. It is an important document as the project transitions into operations because it provides the design thinking and history so that the operations staff understands how the architect and engineers intended the systems to operate.

Develop Commissioning Plan: The commissioning team develops the Cx plan with input from the project team. The Cx plan begins with a program overview: - goals and objectives; general project information; systems to be commissioned. It describes the Cx team members, roles, and responsibilities communication

protocol, coordination, meetings, and management. Finally, it summarises the Cx process activities. Reviewing the OPR; reviewing the BOD; developing systems functional test procedures; Verifying system performance; reporting deficiencies and the resolution process and accepting the building systems.

Installation checks: During installation CxA should perform a visual inspection

and document any issues or relevant observations. Inspect equipment for shipping damages. Verify equipment size, HP, voltage, and other criteria through spot measurements and verify all accessories are provided. Verify connected services do not place stresses on equipment. Verify equipment access and serviceability. Verify that the sensors are checked individually to make sure they are reading properly and are in the correct locations, per the design documents.

Functional Testing: Each equipment is checked to verify that it can open, close, modulate, start, stop, energise in stages, etc. A system is run through each type of operating mode including but not limited to start-up, shut down, capacity modulation, emergency and failure modes, alarm scenarios, occupied mode and unoccupied mode, and interlocks with other equipment. Results indicate whether the system passed, failed, or requires retesting.

Prepare Commissioning Report: The CxA should prepare the cx report after

installation inspections and functional performance test verification. The report covers all components of the commissioning process, including: Executive summary of commissioning process and results, system deficiencies identified and resolution, and outstanding issues.

Training and O&M Manual: Proper training needs to be imparted to facility team to ensure intended operation of systems and equipment. Best way to ensure proper training is to involve facility team during final commissioning process. O&M manual must include: Sequences of operation for the building; building occupancy schedule; equipment run-time schedules; setpoints for all HVAC equipment; lighting levels throughout the building; minimum outside air requirements; changes in schedules or setpoints for different seasons; systems narrative describing the systems and equipment; and preventive maintenance plan for building equipment described in the systems narrative and cx program.

Conclusion

Building Commissioning is not a new subject – it stems from the traditional activities of an architect and engineers throughout pre-design, design, construction and building start-up – but it has developed into a standalone professional specialisation that is now certifiable. The complexity and proliferation of technological building equipment and systems has led to the need for commissioning. A key driver for the growth of commissioning activities is sustainability, which focuses on occupant comfort and energy use reduction. Ensuring that the systems and equipment are installed and function properly will pay for itself many times over through the lower utility bills and increased occupant efficiency. ■

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"HVAC systems plays key role in battle for saving energy"

ALMI International provides flexible, efficient and reliable solutions to all HVAC problems with the energy efficient high-quality products. **Anish Augustine, Managing Director, ALMI International** gives a glimpse of the company, products and services, and much more through opportunity of the interview with **Cooling India**.

Tell us about the milestones that ALMI International has achieved so far.

ALMI International is a young engineering company established in 2012 in United Arab Emirates with a great vision and mission. Currently, we have offices in UAE and India which offer quality products and services to customers or projects in India, UAE, Saudi Arabia, Qatar, Kuwait, Bahrain, Oman and Sri Lanka

What evolutions have you witnessed in the market?

Energy optimisation is an important aspect of operating cost of buildings and industries. An increase in energy efficiency is vital in order to save both our long-term economy and environment.

What are the challenges faced by you while manufacturing or distribution of the products? How do you overcome these challenges?

We are representing some of the world's best manufacturers in this region. Their products are designed for smart and energy saving solutions for various HVAC applications. As these products are tailor-made for each application, we required to have well trained technical team while installation, commissioning and also for future service support. For providing the best customer support for each application, currently, we are having a team of well-trained engineers and technicians with all necessary tools and spare parts.

What opportunities do you envisage for your company with

the Indian government's focus on development of infrastructure projects like metro, smart cities etc?

As we are one of the leading manufacturers or wholesale distributors for the energy saving premium quality HVAC products, we can offer solutions in centralised metering for chilled water, domestic water and gas, tunnel and carpark ventilation systems, kitchen filtration and odor control systems, toxic gas monitoring systems and controlling system and outdoor airflow monitoring systems for metro, malls, hospitals, airports and large-scale buildings

What are your future plans?

In coming years, we wish to have our own manufacturing and testing facility in India as per 'Make in India' program.

ALMI International Products Offering

- Onicon Incorporate USA -BTU meters, Flow Meters, Steam Meters, Thermal Mass Flow Meters, Water Meters etc.
- Air Monitor Corporation USA – Airflow measuring solutions for both indoor and outdoor applications. We can offer both thermal dispersion and differential pressure airflow or pressure measurement solutions.
- Purified Air UK -Kitchen filtration and odor control solutions for hotels, malls, kitchens, restaurants etc.
- QEL Canada – Toxic gas sensors and its controllers.
- Burprovent Germany - Carpark jet fan system and tunnel ventilation systems.
- Mial Instruments India - Measurement instruments, control panels and sensors.

Do you have an export market for your products?

Our products and solutions are export oriented as all countries are currently looking for more energy efficient products for their buildings.

What are the growth drivers of your business?

Energy efficient and premium quality products along with world-class customer service and technical support team are the key to our success.

What is your outlook for HVACR segment?

HVAC industry is the one of the fastest growing segment due to global warming. The HVAC systems have a key role in battle for saving energy. ■

AI, IoT & Big Data: Changing the Face of HVAC O&M

Over the last 4 -5 years, three technological advancements are again changing the way O&M of chillers and HVAC systems is executed - IoT, Big Data analytics and AI. This article gives a brief overview of these disruptors and how the HVAC industry is changing for the better.



Photo Credit: www.robhub.org

In the good old days (not so long ago really), a chiller plant operator would go to the plantroom, open up a big log book and enter the parameters of the chiller plant. The readings would typically be from analog pressure gauges and temperature gauges (many of which would

be showing readings that were just about close to the real values). Once entered into the log book, that was the end of the data recording till the next hourly reading. What happened in between the readings to the chiller was left to the compressor and the evaporator to handle.

Modern HVAC systems in general, and chillers in particular, have come a long way from the day of analog read outs, and sophisticated chiller management systems are standard such systems. The systems are integrated with the building management systems and not only do the

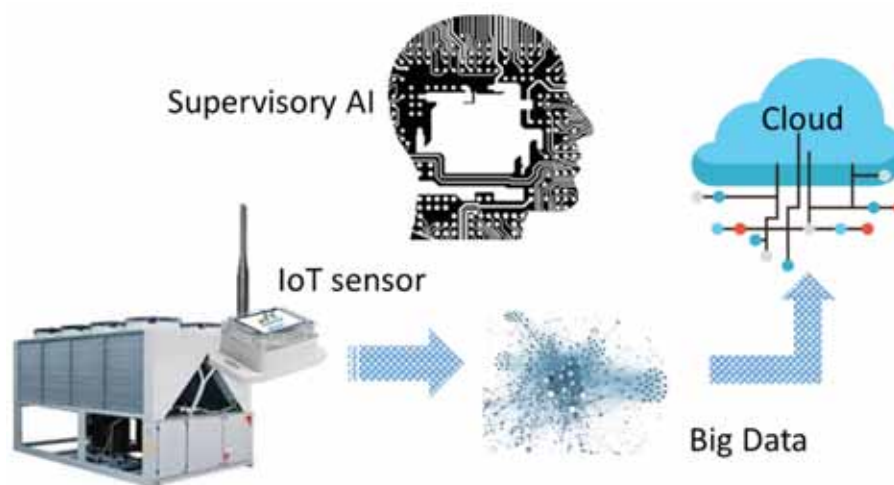


Figure 1: IoT, Big Data and AI

operations and management (O&M) team have access to the status of the system (monitoring), they are also able to in many installations also operate remotely (control) the system. There has thus been a significant level of automation in the HVAC sector, giving a higher degree of monitoring as well as control capability to the O&M teams. Sensors capture thousands of data points within a second and the plant is 'watched' by the controller continuously rather than the once an hour approach of the earlier days. This enables better management of the system and in turn prolonging the equipment's life.

Over the last 4-5 years, three technological advancements are again changing the way O&M of chillers and HVAC systems is executed - Internet of Things (IoT), Big Data analytics and Artificial Intelligence (AI). This article gives a brief overview of these disruptors and how the HVAC industry is changing for the better.

Three Musketeers of the Future – IoT, AI and Big Data

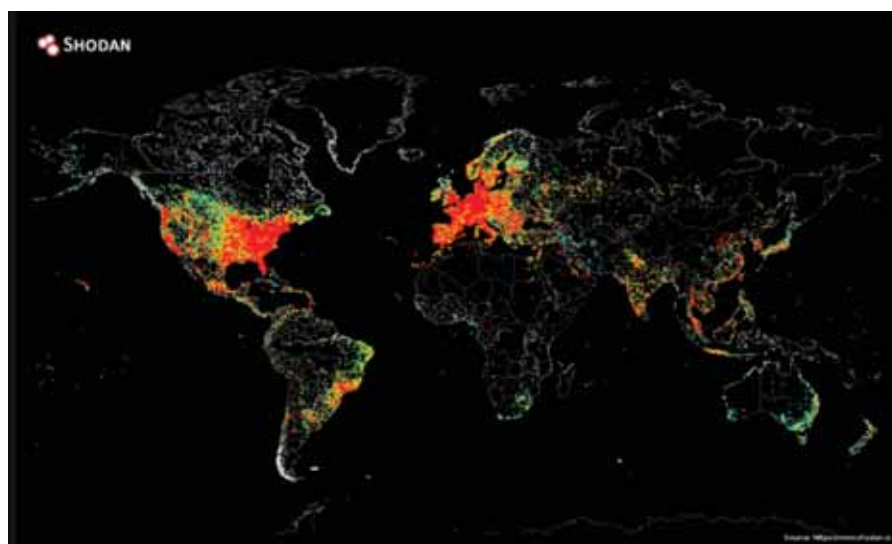
Like the characters of the famous Alexandre Dumas novel, IoT, AI and Big Data are going to help chart a new path for the HVAC industry (in a way, the change has already started). Figure 1 shows how the three trends are connected. Let's understand what these technologies or approaches are.

- **Internet of Things (IoT):** Smart TV is the IoT, fancy ceiling fan which can be

controlled by an app from phone over Wi-Fi is IoT, the wireless energy meter sending real time energy reading to the utility company is the IoT. Essentially, the IoT is a network of devices and sensors connected across the Internet across the globe. These devices are used for control (on/off) as well as collect data from systems, equipment, components etc on a real time basis. As of end of 2017, there were approximately seven billion IoT devices already existing in the world. This number is expected to go up to 20 billion by 2020 and the industry will be a 3-billion-dollar industry – that is the scale of the IoT deployment. Out of these approximately three billion devices will be used in the building sector in HVAC, electrical, space

management etc areas. The picture at the bottom shows the real time IoT devices in use across the world.

- **Big Data:** Imagine the number of readings that these 7 billion devices are taking at any given time – a connected pressure sensor checking the discharge pressure of the gas in a chiller, once every second will take 86,400 data a day - that is a lot of readings, running into trillions of bytes of data. That is the scale that one has to think of when one talks of Big Data. Once one has access to this data, then it is a matter of using powerful algorithm and computers (both big and small) to analyse the data and identify patterns in the data. These patterns could be minor changes in the discharge pressure that could be an indication of a fault condition in the compressor, or repeated spikes in certain values which can give an indication of an abnormal condition. These insights can then be used to proactively intervene and make adjustments, correction or changes in the equipment to enhance the functioning of the system. The characteristics of Big Data are the three Vs – Velocity, Volume, Variety.
- **Artificial Intelligence (AI):** While it is sometimes seen as a scary word (thanks to Skynet of the Terminator movie series), AI is at present not the threat that many think it may be (It may



IoT Devices connected to the Internet



Figure 2: Focus areas for IoT, Big Data and AI implementation

turn out in the future though). AI in the context of the HVAC industry that we are discussing is essentially smart computer programs that are used to help the O&M team optimise the system performance and improve over time through continuous feedback loops. This frees up the O&M teams to spend time on more high-level aspects of their functions like long-term system reliability planning, upgrade management etc. AI is the next step in automation where machines learn (machine learning) to improve system performance, converting information into data and data into insight.

How HVAC O&M is changing through IoT, AI and Big Data

Some aspects of these three transformational technologies are already in use the HVAC industry and operators worldwide are benefiting from the insights that these systems provide. The key areas where the convergence of IoT, Big Data and AI is impacting the HVAC O&M sector are shown in figure 2:

- **Real time monitoring for optimising**

system performance: There are approximately 300 data points that a typical building HVAC system will capture at various intervals – electricity, cooling tower parameters, pumping system readings, chiller controls and operating data points, and AHU readings etc. Currently, the data collection is distributed in most cases and even it is integrated through a BMS, the correlations are not so

evident. With IoT enables floor-wise energy meters, occupancy sensors to track employee usage of floor, wireless temperature sensors on the work floors to update localised temperature fluctuations, remote flow sensors to identify disruptions in flow patterns etc, the intelligent IoT and AI based system will be able to optimise the system performance to suit the localised conditions. Real time local area temperature and weather conditions are analysed by the smart sensors, getting feed from the metrological department. The data is fed to the chiller control system and based on machine learning and AI algorithms, the chiller is started 30 minutes later than the standard starting time when the outside temperature is lower on a particular day due to a sudden thunderstorm.

- **Predictive maintenance through embedded systems and AI:** Advanced IoT based vibration sensors are now available that can be placed in the bearing housing of pumps. These sensors record the vibration patterns of the pump shaft continuously, uploading the data to an analytics engine. The trend of the vibration signature, bearing manufacture bearing L10 life data and comparisons with thousands of pump failure data points is used to assess the condition of the pump in real time and anticipate failure

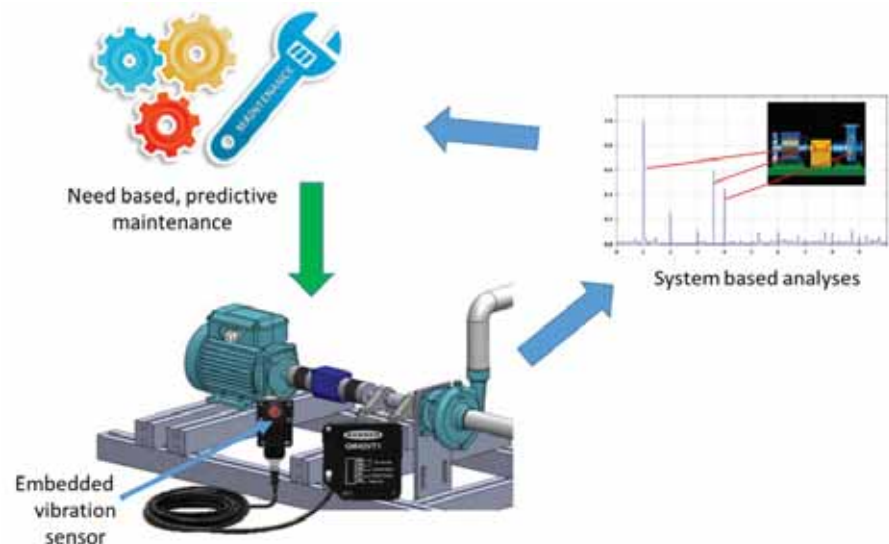


Figure 3: Real time data analytics

before they occur or before the condition deteriorates enough to effect system performance. Figure 3 shows how this process works. The savings in O&M costs is substantial as there is lower down time and lower maintenance efforts as maintenance is need and condition based.

- **Command Centers:** With data now being available 'online, all the time', the requirement of localised control and monitoring reduces significantly. A number of OEMs have already deployed smart chiller management systems that feed a central command center which is manned by the OEMs experts. These systems are able to identify off design operations and possible system defects in real time and intimate the operators to take corrective actions. With increased penetration of IoT devices and lowering of costs of AI engines, the command centers will not only cater to the HVAC system, but the whole building which will enable further optimisation of the HVAC systems performance. Another advantage of command centers is the ability to monitor multiple buildings with lesser resources on the ground, thus, lowering O&M costs.
- **Improving Design using IoT, Big Data:** When a manufacturer has thousands of data points of his/her equipment performance in the real world (and not just factory tests), the design team can analyse the data and get insights to reduce failure or improve efficiency.
- **Benchmarking:** How does one really know that his/her HVAC systems are working at their best? As the famous saying goes, what cannot be measured cannot be managed. Benchmarking is a globally recognised approach to assess one's infrastructure performance with the industry or a defined standard. With IoT and Big Data, it will be easier to compare one building with another not only on the whole building operation but down to the AHU level and pump level. This will allow O&M teams to fine tune the

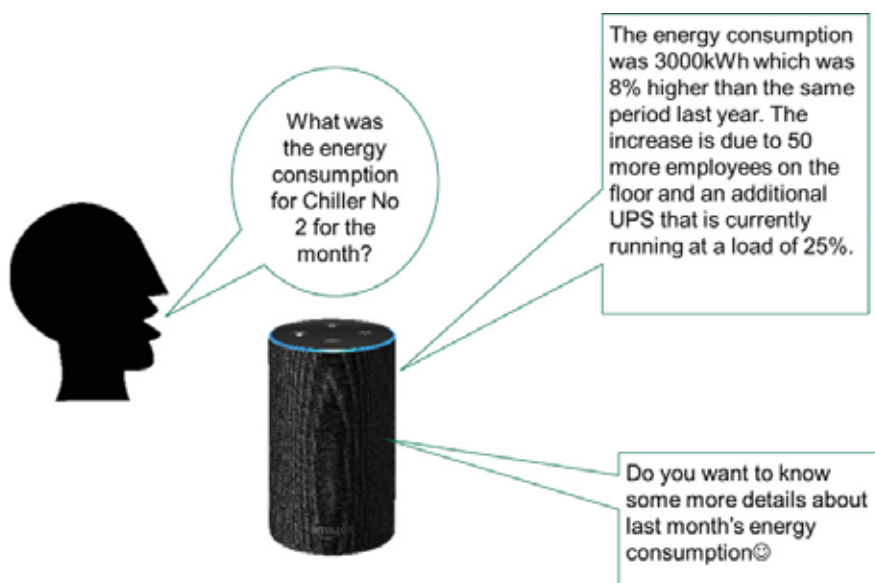


Figure 4: AI for HVAC management

systems, improve on efficiencies and give inputs to the equipment upgrade/ retrofit programs.

AI - What the near future holds for the HVAC industry

While Big Data driven though the proliferation of IoT is an emerging trend, the impact is already being felt in the HVAC sector at least in mature markets and more use cases are being developed. The next disruption will be through the use of AI. What and how exactly will AI transform the HVAC industry is not easy to guess – predicting the future is a risky business as we see all around us. However, AI will be an integral part of the HVAC eco-system is certain. The enhanced computing power of off the shelf machines, lowering of costs of AI development and the ubiquitous 'Cloud' that allows data to be valuable everywhere will be the drivers for the integration of AI with HVAC. Figure 4 shows one possible use of AI that can be a reality in the very near future. Typically, building managers want to know what's happening in their building HVAC system – what is the energy consumption, trends as compared to last year, uptime status etc. Currently, they get this data either through intelligent dash board built over computerised maintenance management systems or they use the traditional way – ask the shift engineer who checks his records and tells the chief

engineer what he wants. With powerful AI systems such as the current favourite 'Alexa' from Amazon, we will soon be witness to the chief engineer asking the connected, AI driven device for an update of the HVAC system. Quite an exciting future that beholds us.

Conclusion

Digitisation of the world around us has already happened – we have convergence of technologies right on the palm of our hand. Smartphones have apps that can give a rough indication of the lux levels of a room or the vibration patterns of an equipment. Thus, the HVAC industry will see a rapid increase in the integration of ecology and this will be primarily through the triad of IoT, Big Data and AI. While there are still many challenges associated with these three technologies such as cost, security, reliability etc., the efficiencies and cost optimisations that they can bring will be drivers to overcome these constraints. The O&M teams that will embrace these advances faster, will be able to leverage them to greater advantage. ■



Flammability Hazards in Refrigeration

Due to the obvious hazards, the use of flammable refrigerants is restricted to controlled environments that have monitors, proper ventilation, explosion-proof equipment and generally few people near the equipment.



Flammability Combustion/ Decomposition of Refrigerants

Flammable refrigerants present an immediate danger when released into the air. The refrigerant can combine with air at atmospheric pressure and ignite, causing a flame and possibly an explosion to occur. Because of the obvious hazards,

the use of flammable refrigerants is restricted to controlled environments that have monitors, proper ventilation, explosion-proof equipment and generally few people near the equipment (refineries, storage warehouses, breweries, etc.).

Some refrigerants can burn with oxygen, but only at higher pressures or temperatures and never in air at

atmospheric conditions. These are called 'combustible' refrigerants. Underwriter's Laboratories (UL) lists these refrigerants as 'practically non-flammable.'

R-22 and R-134a fall into this category. R-22 was found to cause a combustion hazard during a pressurised leak test with air. For this reason, most refrigerants should be used only with pressurised

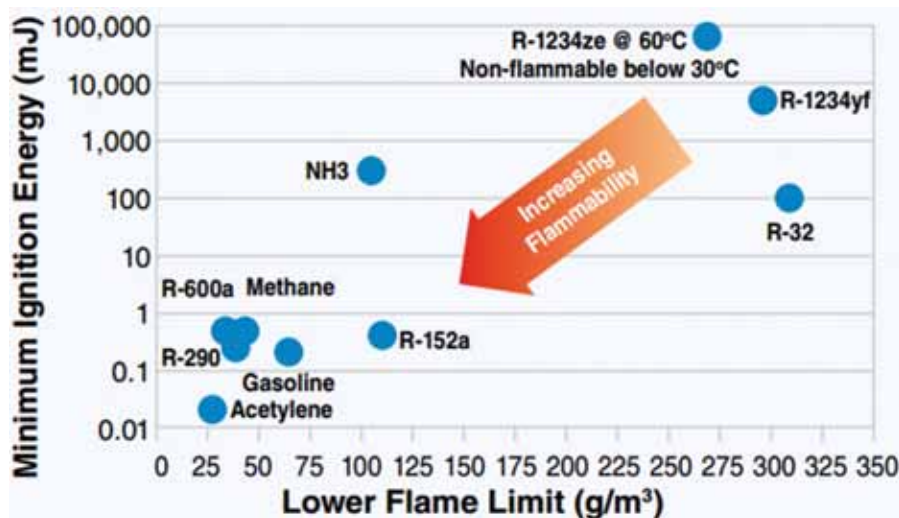


Figure 1: Minimum ignition energy and lower flame limit for selected refrigerants

nitrogen for leak testing. As long as refrigerant is not mixed with large amounts of air, there should be little hazard from these refrigerants during normal handling and use.

Decomposition can occur with any refrigerant when it gets hot enough (generally above 7000° F). Refrigerant can decompose in systems or containers exposed to fire or other extreme heat, electrical shorts (burnouts), or in refrigerant lines being soldered or brazed without being cleared first. Obviously, refrigerant containers or charged systems should never intentionally be exposed to a flame or torch.

When a refrigerant is decomposed or burned, the primary products formed are acids: Hydrochloric acid (HCl), if the refrigerant contains chlorine, and hydrofluoric acid (HF) and fluorine. These products are certainly formed when hydrogen is present such as from the breakdown of oil, water or if the refrigerant has hydrogen attached (like R-22 or R-134a). If oxygen also is present (from air or water), then it is possible to form carbon monoxide, carbon dioxide and various unsaturated carbonyl compounds -- the most notorious of which is phosgene.

Being extremely toxic in small amounts, phosgene formation was a real concern when traditional refrigerants (R11, R-12, R-113, R-114) decomposed. Phosgene contains two chlorine atoms and an oxygen atom. It will only form when oxygen is present and only the refrigerants

with chlorine attached will produce phosgene (not HFCs). R22 has only one chlorine atom per molecule, so, it is extremely difficult, chemically speaking, to get another one attached to form phosgene. Decomposition of R-22 or HFCs may form other carbonyl fluorides, however, they are not as toxic as phosgene.

The standard practice for handling decomposed refrigerant is to collect the gas, treat the refrigerant and/or the system for acid contamination, and appropriately dispose of the burnt gas. Please note that any cylinder or system component exposed to high heat or fire should be retested or discarded. Cylinders used to recover burnt gas should be checked and cleaned before being put back into service, especially the valve and/or pressure relief device.

Flammability Characteristics of Refrigerants

Flammability is a property of a mixture in which a flame is capable of self-propagating for a certain distance. Generally, flammability of a refrigerant is its ability to burn or ignite, causing fire or combustion. The degree of difficulty required to cause the combustion of a substance is quantified through fire testing and dependent on a number of parameters discussed below:

When the substance is flammable depends upon the upper and lower flammability limits and the supplied energy for ignition. The consequences of the flammability event depend on the burning velocity, heat released and by-products of combustion.

Mixtures of refrigerant and air will burn only if the fuel concentration lies within well-defined lower and upper bounds determined experimentally referred to as flammability limits.

Lower Flammability Limit (LFL, per cent by volume or g/m³): minimum concentration of the refrigerant that is capable of propagating a flame through a homogeneous mixture of the refrigerant and air under the specified test conditions at 23.0°C and 101.3 k Pa. At a concentration in air lower than the LFL, gas mixtures are too weak to burn. Methane gas has a LFL of 4.4 per cent. If the atmosphere has less than 4.4 per cent methane, combustion cannot occur even if a source of ignition is present.

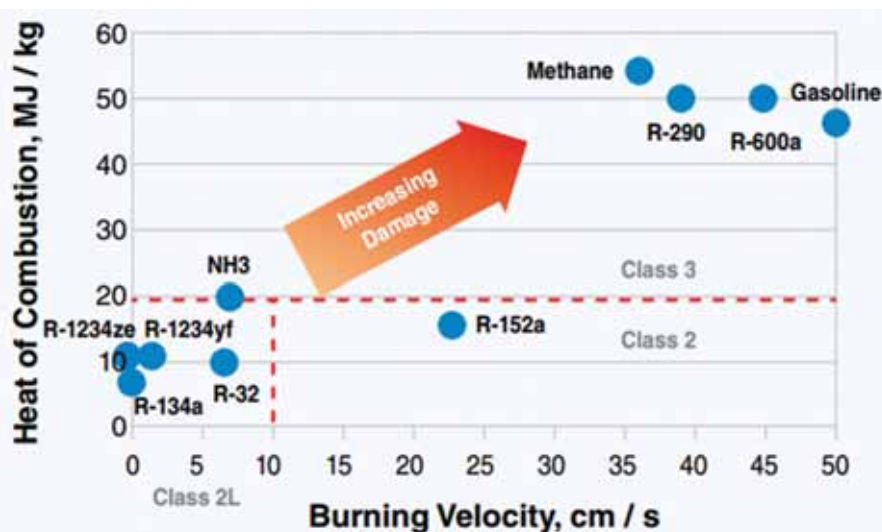


Figure 2: Heat of combustion and burning velocity for selected refrigerants

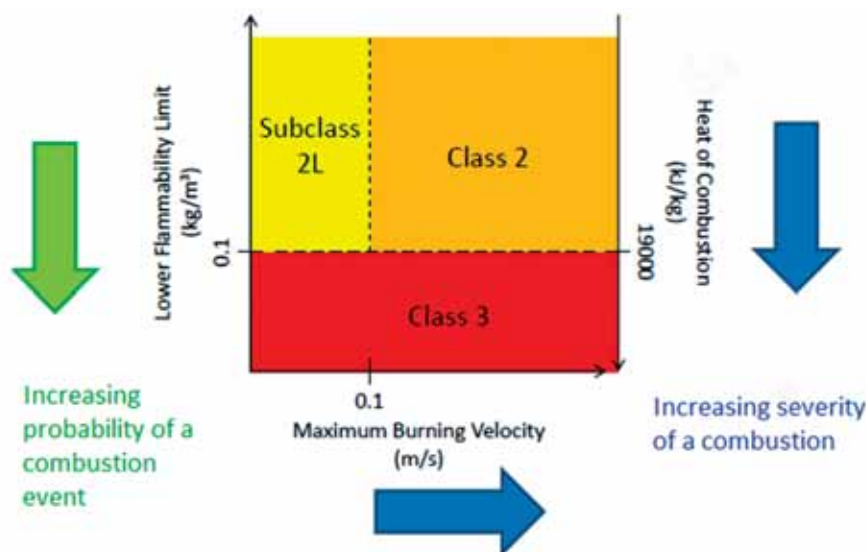


Figure 3: Flammability classes of flammable refrigerants according to ASHRAE standard 34

Upper Flammability Limit (UFL) is the highest concentration of a gas or a vapour in air capable of producing a flash of fire in presence of an ignition source (arc, flame, heat). Concentrations higher than UFL are 'too rich' to burn.

Burning velocity is velocity relative to the unburnt gas (normally in cm/s), at which a laminar flame propagates in a direction normal to the flame front at the concentration of refrigerant with air giving the maximum velocity.

Heat of combustion is the heat evolved from a specified reaction of a substance with oxygen.

Standards & Classification

Standards provide limitations and recommended practices on how to properly handle different refrigerants, including flammable ones.

ASHRAE standard 34 "Designation and Safety Classification of Refrigerants" classifies refrigerants based on their flammability and toxicity characteristics. It recognises several flammability classes from non-flammable A1 to highly flammable A3, depending on refrigerant's LFL value, heat of combustion and maximum burning velocity.

Similarly, to ASHRAE standard 34, standard ISO 817 'Refrigerants -- Designation and Safety Classification' provides an unambiguous system for assigning designations to refrigerants and its flammability on international levels.

European Standard EN 378 'Safety and Environmental Requirements for Refrigeration Systems and Heat Pumps' aims to reduce the number of hazards to persons, property and the environment caused by refrigerating systems and refrigerants. It, therefore, regulates the usage of flammable refrigerants in systems depending on system location, occupancy level, system type and refrigerant used. Current edition of EN378 standard was published in 2008 and do not directly recognises the A2L flammability refrigerants. It can be expected that the standard will be accordingly updated in its new edition that is currently under development.

In other countries the safety on refrigeration system level is regulated by ASHRAE Standard 15 'Safety Code for Mechanical Refrigeration' (US) and ISO 5149 "Refrigerating systems and heat pumps – Safety and environmental

requirements" (internationally). On the equipment level safety is regulated by, for instance, European standards EN 60335-2-34 and EN 60335-2-40.

Lower Flammability Refrigerants

To be deemed mildly flammable, a substance must burn at a velocity no greater than 10 cm/s. By comparison, Usain Bolt's world record 100-metre time equates to 1043 cm/s, while hydrocarbons burn many times faster.

The need for more precise flammability index was proposed in ISO 817 revision working group (WG) in 1999. This proposal was to extend the relaxed anti-explosion requirements for ammonia, which was already well-known as difficult to ignite substance, to all similar or lower flammability refrigerants. The WG concluded to employ burning velocity as an additional category in 2002 with the upper boundary of 10 cm/s. This category was named 2L to distinguish from conventional flammable class 2. ASHRAE34 adopted this concept in 2010, while ISO 817 finally adopted in 2014.

In order to ensure safe use of refrigerants with this flammability class and to open up a path for lower GWP refrigerants in the class, experts on the issue have conducted research and development for more than 10 years. Many risk assessments were conducted or being conducted. They indicated that 2L refrigerants' flammability is acceptable for air conditioners and heat pumps when these systems comply with standards for equipment safety such as EN 378.

It can be seen that flame of mildly flammable refrigerants R-32 and ammonia do not propagate horizontally due to their low burning velocities. Additionally, the range of impact of the combustion of 2L refrigerants is limited due to their low heat of combustion (that is specifically visible for refrigerant R-32).

Table 1: Behaviour of Flames of different refrigerants

Classification	A3	A2	A2L	B2L
Substance	Propane	HFC-152a	HFC-32	Ammonia
Burning velocity	39 cm/sec	23 cm/sec	6.7 cm/sec	7.2 cm/sec
Heat of combustion	46 MJ/kg	16 MJ/kg	9 MJ/kg	19 MJ/kg

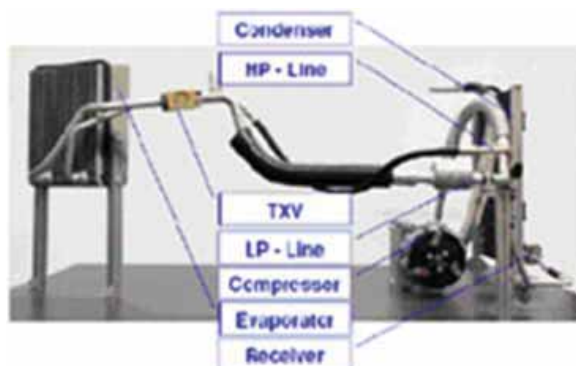


Figure 4: R134a A/C system (VW Lupo)



Figure 5: Test adaptations to R134a A/C system (VW Lupo)

Flammability Investigation of Different Refrigerants

A flammability investigation of three different refrigerants was carried out. In a first step the actual safety level of R134a was investigated. The results were put in relation to the two possible alternatives R744 and 2,3,3,3 –Tetra fluoro propene (also called HFO-1234yf).

Test Setup

A VW Lupo system was used to do the testing. The system was charged with refrigerant (500gr for R134a and HFO-1234yf) and operated under real operating conditions (Pd ~15bar). As lubrication medium PAG oil ND8 (135ml for all tests) was used. A possible leak of the refrigerant caused by a front-end collision was simulated by a release of refrigerant through a manually operated valve onto a hot surface. Such a front-end collision can rupture a refrigerant line and release the refrigerant-oil mixture into the engine compartment. The released refrigerant-oil mixture was directed to a hot surface simulating a turbo charger or hot exhaust manifold. The surface temperature was measured and the temperature was adjusted through a controller of the electrical powered heat source.

Base Line Test

The base line test with R134a (ignition temperature >743°C) and ND8 (flash point 204°C) was carried out to define the existing safety level in the vehicle. A surface temperature of 970°C was chosen. Under this condition, it was possible to show that the R134a prevents the mist of oil and refrigerant vapor from ignition. During this test no flame propagation was

observed. It could be concluded that the use of R134a and ND8 oil is safe up to surface temperatures of 970°C.

Second Test

In a second test, R134a was replaced by R744 (charge of 50gr and additional R744 container of 20kg was connected to the system) and the test was repeated at the same surface temperature of 970°C. Since the oil circulation rate in a R134a system is higher (~4 per cent) and more refrigerant is solved in the circulating oil than in an R744 system, the risk of mist ignition and the causing of a pilot fire is reduced with the inflammable refrigerant R744. In a normal operating, R744 system pressures are higher than in the one used during the test. However, the lower-than-normal pressures of the R744 system are considered to increase the risk of ignition since a higher pressure would cause also higher release speeds and therefore, reduce the probability to ignite the mixture. In the test, the release pressure was stabilised to 20 bar. No misting was observed and no ignition was observed.

Third Test

The third test was carried out with 2,3,3,3-Tetrafluoroprop-1-ene (also called HFO-1234yf) and having a flash point of ~400°C. Miscibility and solubility characteristics with ND8 are considered to be similar to R134a. During the testing an ignition was observed and the flame propagation and the flammability envelop was judged to be substantial.

Conclusions

R134, having an A1 rating (not flammable according to ASHRAE safety standard), can not be ignited during an

accident simulation (vehicle front end) and under realistic operating conditions including circulating oil. R744, having also an A1 rating, behaves similar to R134a and the risk of ignition can be judged to be lower than with R134a. R744 is, therefore, generating an improved safety level. The HFO-1234yf, with a probable ASHRAE safety rating of A2 or an even lower safety level in terms of flammability and toxicity (toxicity testing not completed) clearly increases the risk of a pilot fire after a front-end collision.

Incident 1: 1992 – At a meat packing plant, a forklift struck and ruptured a pipe carrying ammonia

In 1992 incident at a meat packing plant, a forklift struck and ruptured a pipe carrying ammonia for refrigeration. Workers were evacuated when the leak was detected. A short time later, an explosion occurred that caused extensive damage, including large holes in two sides of the building. The forklift was believed to be the source of ignition. In this incident, physical barriers would have provided mechanical protection to the refrigeration system and prevented a release.

Incident 2: 1999 - An explosion in the machine room of chiller 1A 100 level refrigeration plant

On Sunday 24th October 1999, an explosion took place in the machine room of chiller 1A 100 level refrigeration plant. At the time, 14 people were working in close vicinity of the compressor where the explosion occurred and seven people were hospitalised for smoke inhalation. The refrigeration plant originally operated on CFC12, was purchased in 1967, and would have been commissioned during



Figure 6: Grenfell Tower Fire

1968-1969. The plant is located in the first chamber (1A) of 5 chambers situated on 100 level Tau Tona. Each chamber houses two refrigeration plants. The plant was not retrofitted; however, a HFC134a 'drop-in' was done by the mine at an unknown date. The compressor and original relay logic was replaced with a programmable logic controller (PLC). The compressor was fitted with a non-original equipment manufacturer (OEM) stainless steel impeller for use with CFC12.

Two possible explanations for the explosion emerged.

- i. Air entered the compressor and a high-temperature, high-pressure mist comprising of HFC134a, oil and air ignited resulting in the explosion.
- ii. A second possibility is that the pressurised HFC134a and oil mist escaped past the red-hot journal bearing metal of the damaged

compressor and mixed with the surrounding air. Under these conditions, the mixture ignited causing an explosion.

Incident 3: 2017 – The Grenfell Tower Fire

The Grenfell Tower fire occurred on 14 June 2017 at the 24-storey Grenfell Tower block of public housing flats in North Kensington, Royal Borough of Kensington and Chelsea, West London. It caused at least 80 deaths and over 70 injuries.

Investigation revealed that the fire started accidentally in a fridge-freezer on the fourth floor. The fridge was using R 600 (n Butane) as refrigerant though it was not confirmed if leaking refrigerant was the cause of fire.

The rapid growth of the fire is thought to have been accelerated by the building's exterior cladding, which is of a common type in widespread use. An independent review of building regulations and fire

safety has been launched.

Emergency services received the first report of the fire at 00:54 local time. It burned for about 60 hours until finally extinguished. More than 250 firefighters and 70 fire engines from stations all over London were involved in efforts to control the fire. Over 100 London Ambulance Service crew on at least 20 ambulances attended, joined by the specialist Hazardous Area Response Team. London's Air Ambulance sent teams of HEMS doctors and paramedics by road in support.

Fire fighters rescued 65 people. It was presumed that the building's structure could contain a fire within a single flat, but in this case the fire was spreading rapidly via the building's exterior.

General Fire Safety Precautions

- Keep torches away from combustible materials
- Always keep a fire extinguisher nearby when working with flammable materials
- Use a fire shield when soldering near combustibles
- Never solder tubing on a sealed system as pressure could develop
- Take proper precautions when working near motors and hot pipes
- Take proper precautions against heat related illnesses when working indoors or outdoors in extreme heat
- Explore the possibility of heat accumulation

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Johnson Controls' new tools to showcase energy conservation

New Tenant Management and Kiosk features allow building owners to access and share real energy and sustainability data with tenants and the public.



Johnson Controls expands the capabilities of its comprehensive, analytical, cloud-based optimisation platform, Metasys Enterprise Management (MEM) by introducing several new features. The new Tenant Management enhancement gives tenants and building owners visibility into real energy consumption through personal dashboards, while Kiosk enables building owners to showcase their properties' energy conservation and sustainability programs to the public.

With the new Tenant Management feature, tenants can now track their energy consumption and cost and make online after-hour requests. Building owners can compare and analyse the energy consumption and spend of each tenant, track trends and see a summary of after-hour requests for each tenant. Using this information, a building owner can suggest corrective action to help tenants lower their energy costs.

The Tenant Billing feature calculates true consumption of

multiple commodities (electricity, gas and water) and auto-generates bills. This assures tenants pay only for their energy consumption, rather than a flat rate based on square footage.

Kiosk is a powerful, new, public-facing tool that enables building owners to share a dynamic and interactive experience, highlighting real-time energy reduction. It displays live data, including current energy and water usage, reductions in CO₂ emissions and outdoor air conditions. It also informs users and visitors about their organisations' environmental impact, LEED certification and ENERGY STAR goals.

"Johnson Controls is dedicated to providing quarterly enhancements to the Metasys Enterprise Management platform to strengthen the customer experience and create new possibilities for our current and future customers," said Terrill Laughton, Vice President and General Manager of Energy Optimisation and Connected Offerings, Johnson Controls. "In addition to the new features, we also made the platform available in five new languages – Brazilian Portuguese, Italian, Japanese, French and Dutch -- in addition to the original English, German, Chinese and Spanish (European) language offerings."

Metasys Enterprise Management works with energy meters, smart devices and building automation systems to continuously extract otherwise overwhelming amounts of energy and equipment data. This data is securely transmitted to the Cloud, where it is proactively analysed 24x7, identifying faults and opportunities for improved performance and operational savings. Intuitive, out-of-the-box dashboards display the aggregated data and actionable information. Using the platform, facility personnel can create work orders and then track progress toward the solution. ■

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TOP 10 FAQ:

24°C AC temperature setting

Here we have assembled a list of answers to the top 10 most frequently asked questions on BEE (Bureau of Energy Efficiency) recommendations on temperature setting of air-conditioners.



1. What is the objective of the BEE for recommending optimum temperature setting of air-conditioners?

Bureau of Energy Efficiency (BEE) has issued the guidelines to major commercial establishments with the objective of conserving energy through optimum temperature settings for the air-conditioners, within the comfort zone or chart. It is estimated that changing the temperature from conventional 20-21 degree Celsius can result in approximately at 24 per cent of energy savings.

2. What is the estimated saving potential due to this initiative?

Overall potential for energy conservation through such measures is estimated to the tune of 20 billion units (worth Rs 10,000 crore) annually. If about half (50 per cent) the consumers adopt to such recommendations, this would



A recent CSE study has shown that almost up to 50% of electricity used during summer months in Delhi is consumed only for cooling. This quantum is so big that it can power nine cities the size of Chandigarh during summer months.

result in about 10 billion units of electricity, which is equivalent to reduction of 8.2 million tonne of CO₂ per year.

3. What does default setting at 24-degree C mean? Whether the consumers will be able to adjust their ACs to a lower temperature?

Default setting is the setting at which a machine comes from the factory. Therefore, when the machine is switched on then it will have a preset temperature of 24-degree C. However, a user can adjust or set the air-conditioner at a lower (or higher) temperature, as per her choice.

4. Why is it beneficial to preset the temperature of AC equipment at 24-degree C?

Normal human body temperature is between 36-37 degree C. It is generally observed that in large commercial establishments like hotels, airports and offices, the AC operating staff, try to set the lower temperature (around 18-21 degree C), believing that it indicates a better cooling performance of AC system. However, technically this is not true and the cooling action of compressor is same at other settings also. On the other hand, setting the temperature in the range of 18-21 degree C results into a very cool internal ambient conditions, which compels people to wear warm clothing leading to wastage of energy. As per the comfort chart, the temperatures upto 25-degree C are quite comfortable for human body, along with desired humidity and air movement values.

5. If there are more persons in the room, will it be possible to maintain comfort conditions?

The same temperature setting would enable AC equipment to provide sufficient cooling, even if there are more persons. The compressor will work slightly longer till such time equilibrium is reached.

6. What are the advantages of setting AC default temperature at 24-degree C?

It is estimated that by increase in temperature of room by 1 degree C, we can save about 6 per cent of electricity. Typically, room temperature is set between 20-21 degree C whereas, as per standard comfort conditions, ideal temperature is 24-25 degree C. Considering change from 20-degree C to 24-degree C, there is potential to increase at least 4 degrees C, which will lead to savings of about 24 per cent of electricity. Therefore, the users will be able to save significant amount of energy (and money) by running their air-conditioners at 24-degree C.

7. Which are the potential buildings or areas that BEE is targeting to implement the guidelines?

The guidelines have been recommended to the major commercial establishments such as airports, hotels, shopping malls, offices and government buildings (ministries and attached offices, state government and public-sector undertakings).

8. Is the advisory mandatory right now?

The advisory for the commercial establishments has been issued for voluntary adoption. The aim is to increase awareness and encourage consumers to adopt the guidelines. A public survey would be conducted after 4-6 months awareness campaign

by the Ministry of Power/BEE.

9. Does setting the thermostat at 18-degree C cool the room faster than keeping it at 24-degree C?

No. The thermostat just checks the temperature of the air inside the room and stops the compressor when the temperature reaches the desired level. This means that the compressor will work longer if the temperature is set to a lower level, i.e. it will work more and use more electricity if temperature is set to 18-degree C than if it is set to 24-degree C.

This is because it will take less time for air to reach to 24-degree C than 18-degree C, as the compressor is working with the same power or wattage.

10. Why is this move important for India?

BEE estimates that considering the current market trend, total connected load in India due to air-conditioning will be about 200 GW by 2030 and this may further increase as today only 6 per cent of households are using one or more air-conditioners. If the measures are followed by all consumers, India can save about 23 billion units of electricity. The total installed capacity of air-conditioner is about 80 million TR, which will increase to about 250 million TR in 2030. ■

(Source: PIB/Ministry of Power)

REFCOLD INDIA to Set New Standards for Cold Chain Industry

The refrigeration and cold chain industry in India would witness a pristine scale and focus of bringing together the best of technology and business in November 2018. The Indian Society of Heating, Refrigerating and Air Conditioning Engineers (ISHRAE) and NürnbergMesse India have launched a brand-new exhibit REFCOLD INDIA for the Refrigeration and Cold Chain industry.

REFCOLD INDIA will be one-of-its-kind exhibit whose sole objective would be to ensure a well-rounded growth of the refrigeration and cold chain industry in India. There would be augmentation in business, innovations, technology and sustenance.

The event, in effect, would be an endeavor to cover all the varied sections of the refrigeration and cold chain industry and bring together the vast base of business prospects under one roof. It will also be the arena for the global investment community to connect with stakeholders

in refrigeration and cold chain sector in India.

REFCOLD INDIA will mark its debut on November 22. It would be a three-day event that will close on November 24. The venue, Mahatma Mandir Convention Cum Exhibition Centre in Gandhinagar, Gujarat, is aptly chosen for its size, grandeur, technological preparedness and the distinct character reflecting the prosperity of Gujarat.

Pankaj Dharkar, Chairman of REFCOLD INDIA excitedly mentioned, "We are thrilled to have finally launched REFCOLD INDIA. The refrigeration and cold chain industry in India needed a symposium where the focus would lie solely on this sector. From its debut year itself, REFCOLD INDIA would cover all aspects of the industry, which mainly are – the resources (cold chain services), the process (cold transportation and equipment) and the products (cold storage and equipment). I welcome all associates, partners, visitors and media to

this promising platform and am confident that it would help us take the industry to the next level of knowledge and business exchange".

In global terms also, the cold chain Industry in India is developing at a much faster pace, owing to the general change in the business outlook. While earlier, the focus at all times would be on increasing the production level, the market now is concerned about optimisations in terms of better storage and transportation facilities for their respective commodities. Hence, cold chain management has now become an integral part of the supply chain industry comprising of refrigerated storage and refrigerated transportation. This makes it essential for all businesses to invest in infrastructure that should help reduce wastage.

With this promise and prospect, the cold chain industry in India is forecasted to grow at a CAGR of 19 per cent during the period of 2017-2022. ■

Symposia 2018 Focuses on Increasing Energy Efficiency in Data Centres

'Symposia 2018' majorly focused on bolstering an infrastructure for data centres where energy efficiency is a core concern. The conference aimed towards bringing renowned exhibitors, consultants from data centres industry on a single platform to discuss various possibilities that can be explored to build a data centre ecosystem that ensures optimised power usage...



With the theme, 'All about Data Centres – Convergence of All Stakeholders', ISHRAE Mumbai Chapter has successfully conducted its flagship event 'Symposia' on July 6, in Mumbai.

'Symposia 2018' majorly focused on bolstering an infrastructure for data centres where energy efficiency is a core concern. The conference aimed towards bringing renowned exhibitors, consultants from data centres industry on a single platform to discuss various possibilities that can be explored to build a data centre ecosystem that ensures optimised power usage. The seminar covered various aspects of designing, building and operating a data centre from the point of view of air conditioning and refrigerating which are essential components of energy consumption.

Key dignitaries present for the inaugural were Murari Sinhal, Group Senior Vice President in Reliance Industries, Prakash C Lohia, Senior Vice President (Power & Utility) Reliance Industries; Sanjay Jadhav, Vice President – Product Business, STULZ – CHSPL (India); Suresh Balakrishnan, Co-Founder & Joint Managing Director, STULZ- CHSPL (India); Sudipta Sanyal, Design Head – Data Centre (Global), Sterling & Wilson; Shyam Surve, Head – Modular Data Centre, Sterling & Wilson; Maurizio Frizziero, Director – Data Centre Cooling Product Management ID Division, Schneider Electric; Manish Gokhale, Director – Business Development IT Division, Schneider Electric; Tushar Wedhikar, i.d.a. International, Singapore among other industry players.

Symposia 2018 brought together over 250 delegates from the data centres industry and also, delegates and decision makers from all the end users (corporates, industries, banks), PMC's, system integrators, consultants (ACs, electrical, UPS), telecom service providers, IT Infra (Structure Cabling, Rack Manufacturers), monitoring system providers, safety solution providers all under one roof. Prestigious associations such as AWESOME, FSAI, IAEMP, IFMA, IGBC, RATA and IPA extended their support to the conference.

Symposia 2018 also provided a platform for discussion of contemporary topics like hyper-scale data centres, future trends in data centre cooling/ Micro DC, cold wall or AHU for data centres, modular data centre.

ISHRAE is an association of 12000 members of HVAC&R engineers across India with the presence in 41 cities. It also has 10,000 student members. The main goal of ISHRAE is disseminating the knowledge of HVAC&R through training and courses. Symposia is one such national event. Other such events are ISHRAE Certified Professional courses in HVAC&R industry.

C Subramaniam Mani, National President, ISHRAE said, "Optimised energy usage in data centres is a major challenge for all the companies as the data centres are running redundant power and cooling systems that consume a lot of energy. Hence, companies are looking for solutions to strategically manage energy and make data centres energy efficient while reducing the power costs down. 'Symposia 2018' a program designed by

ISHRAE Mumbai Chapter emphasises on the prominent issue of energy consumption in data centres and focuses on delivering solutions to strategically optimise air conditioning and refrigerating facilities to reduce the energy consumption."

"Symposia 2018 showed ways to reduce energy consumption and related costs. The event provided a platform for the discussion topics like insight or in-depth of futuristic data centre trend. Latest technology solution possibilities in the data centre industry. The topic was well received by the industry experts and we are happy to see the response," said Sangita Jhangiani, President ISHRAE Mumbai Chapter.

"Symposia is a national program for ISHRAE Mumbai Chapter with different niche themes every year. This year's theme, 'All about Data Centres – Convergence of All Stakeholders' covered various aspects of building an infrastructure for data centers where energy efficiency is most important. The event also showcased all the innovative technologies in HVAC&R industry which can be used to ensure the optimized energy usage in the data centre," informed Mihir Sanghavi, President-elect ISHRAE Mumbai Chapter.

Shankar Sapaliga, President of ASHRAE Mumbai Chapter & Director of West - 1 of ISHRAE said, "As President of ASHRAE Mumbai Chapter & Regional Director of West - 1 of ISHRAE, it is



Photo courtesy: www.jakaraglobe.id

my responsibility to organise program for the members jointly. In Addition to the technical program, we conduct for members we also organise program for student members like ISTL. Another initiative we have started is organising IJJ (ISHRAE Job Junction) where we invite industry leading companies and the students for interaction with each other so that students are able to get an insight into companies, which help them when they join the organisation." ■

Bitzer Enlarges its Selection Software

The latest update of the Bitzer software allows customers to calculate the performance data for even more components within the compressor specialist's product range. With this, Bitzer offers a reliable tool for users to select the appropriate components for their systems.

The software updated to version 6.8 now includes the newly introduced ORBIT+ and ORBIT FIT scroll compressors for the refrigerants R410A, R454B and R32 as well as the CSVW variable speed compact screw compressor series with permanent-magnet motor. Furthermore, users can now carry out the motor selection for Bitzer OS.95 screw



compressors. As for reciprocating compressors, Bitzer has added the Varipack frequency inverter selection for its ECOLINE+ series as well as for the two-stage semi-hermetic reciprocating compressors.

Now, users have the possibility of customising the dimensions of Bitzer liquid receivers and condensers. The necessary documents can be downloaded in the software via the 'Dimensions' button. BITZER has added new refrigerants for the receiver calculation. Also, the company's largest horizontal oil separator OAHC100051A for ammonia applications has been made available with the update. ■

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A New Facet to Building Design

Indoor air quality crosses economic status, race and ethnicity. Poor indoor air quality can be present at work, home, school or vehicles. Hence, this is a subject that needs to be addressed carefully for our present as well as future well-being.



Photo Credit: www.zone2blog.wordpress.com

Most people spend as much as 90 per cent of their time indoors. They ingest almost three to four liters of water and one kg of food daily but inhale almost 15 liters of air each day. Therefore, maintaining a superior Indoor Air Quality (IAQ) in occupied spaces can translate to occupant health and safety,

greater productivity and reduced healthcare costs.

Indoor air is often more polluted than outdoor air (albeit with different pollutants). Research has shown that indoor air in buildings can be two to five times—and occasionally up to 100 times—more contaminated than outdoor air. In fact,

indoor air is often a greater health hazard than the corresponding outdoor setting, although this has not changed the common understanding of air pollution.

Indoor air pollution consistently ranks among the top five environmental risks to public health. US Occupational Safety and Health Administration (OSHA) estimates



that 30 per cent of workers in non-industrial buildings—including offices, schools and hospitals—are exposed to poor indoor air quality.

The World Health Organisation (WHO) estimates that 4.3 million people in 2012 lost their lives due to indoor air pollution. Estimates from the WHO and others suggest that between 30 and 150 times more people are killed due to indoor air pollution than global warming.

Air tight buildings made for higher energy efficiency - if not provided with sufficient ventilation - lead to a common problem viz. build-up of carbon dioxide and various pollutants. This leads to 'sick building syndrome,' the term introduced in 1980s to describe the increasingly common maladies caused by improperly designed and ventilated buildings. By 1984, a WHO Committee reported that "up to 30 per cent of new and remodeled buildings worldwide may be the subject of excessive complaints related to indoor air quality. Since that time, consciousness increased on this subject mainly in the developed countries and standards were introduced.

What is Indoor Air Quality?

IAQ is one of the most important areas of Indoor Environmental Quality (IEQ), particularly, in terms of the impact of a building on the health of occupants. IEQ encompasses more than air quality, including thermal comfort, visual comfort and acoustical quality.

IAQ deals with the content of interior air that could affect health and comfort of building occupants. It refers to the presence or absence of air pollutants in buildings. There are many different types of pollutants that can affect indoor air, and they come from a wide range of sources.

According to the US Environmental Protection Agency (EPA) and National Institute of Occupational Safety and Health (NIOSH), the three key elements that contribute to the quality of the air people breathe when they are inside include:

- Introduction and distribution of adequate ventilation air
- Control of airborne contaminants
- Maintenance of acceptable temperature and relative humidity.

How does Indoor Air Pollution Impact us?

Poor IAQ leads to a variety of health

risks that have significant costs for the people affected directly, as well as for their family members, employers and society at large. Despite the fact that IAQ can have an immense impact on health and general quality of life, it is generally an unregulated field.

The Environmental Protection Agency notes that occupants may experience adverse health effects from indoor air pollutants soon after exposure – or years later. Health conditions associated with poor IAQ can be categorised as either building related illness (BRI) or sick building syndrome (SBS).

• Building Related Illness (BRI)

As defined by the *World Trade Center Resource Guide*, BRI includes specific, identified maladies attributed to an identified material, product or system in a home or building. Examples include Legionnaire's Disease, hypersensitivity pneumonitis, humidifier fever and asthma-like symptoms in non-asthmatic individuals. Approximately 25 per cent of the ailments associated with indoor air quality can be identified specifically and are attributed to BRI.

• Sick Building Syndrome (SBS)

SBS refers to a general set of symptoms that affect building occupants during the time they spend in the building and that diminish or go away during periods when they leave the building. SBS cannot be traced to specific pollutants or sources within the building, and it typically is multi-factorial, or caused by a number of factors combined with or worsened by



Table 1: Common Indoor Pollutants and Sources

Contaminant	Description	Common sources
Biological Contaminants	Biological contaminants are a natural and unavoidable part of the world. They are so small, so numerous and so adaptable that they cannot be eliminated from most indoor environments. However, the built environment can be made less hospitable to them by source control of mold and moisture.	Common sources may include, people, animals, water, soil, plumbing leaks, water damaged buildings, standing water in HVAC system, plant debris
Combustion Products	Combustion—in heating, cooking, smoking, transportation and power generation — is intrinsic to the activity of people and buildings. Unfortunately, combustion also releases numerous compounds that can potentially contaminate indoor air.	Unvented or malfunctioning gas appliances, tobacco smoke, fireplaces, furnaces, automobile exhaust from attached garages etc.
Particulate Matter (PM)	PM is a complex mixture of extremely small particles and liquid droplets in the air, many of which are hazardous. It includes aerosols, smoke, fumes, dust, ash and pollen. Any material within a building can under certain conditions, emit or form particulates, which could then be inhaled and possibly lead to health risks.	Tobacco smoke, fireplaces, furnaces, aerosol sprays, carpet (shedding fibers), ceiling tile, insulation, textured fabrics, printers and copiers
Volatile Organic Compounds (VOCs)	VOCs are a large group of carbon-based chemicals that easily evaporate at room temperature. While most people can smell high levels of some VOCs, other VOCs have no odour. There are thousands of different VOCs produced and used in our daily lives such as Acetone, Benzene, Ethylene, glycol, Formaldehyde, Methylene chloride, Perchloroethylene, Toluene, Xylene, 1,3-butadiene. Studies have shown that the level of VOCs indoors is generally two to five times higher than the level of VOC's outdoors. Some VOCs are carcinogens, suspected carcinogens or known irritants at typical levels.	Building Materials, Carpets and adhesives, Composite wood products, Paints, Coatings, sealants, Solvents Upholstery fabrics, Varnishes, Vinyl Floors, Wall Coverings, Cleaning and Personal Care Products, Air fresheners, Air cleaners that produce ozone, Cleaning and disinfecting chemicals, Cosmetics, Fuel oil, gasoline
Formaldehyde	It is a colourless, flammable gas at room temperature and has a strong odor. Exposure to formaldehyde may cause adverse health effects. At higher concentrations in air, inhaled formaldehyde can irritate the eyes and mucous membranes, resulting in watery eyes, headache, a burning sensation in the throat and difficulty breathing.	Adhesive resin, including urea formaldehyde and phenol formaldehyde, used in manufactured wood products. Examples include, Particle board, fiberboard, plywood and medium-density fiberboard (MDF); glues; manufactured wood products, such as furniture; preservatives; permanent press fabrics; paints; inks; paper product coatings; insulation; pesticides paper products

inadequate ventilation. About 75 per cent of building-related health cases are classified as SBS. Common SBS symptoms include headaches, nose, eye and throat irritation, a dry cough, dry skin irritation, dizziness or nausea, difficulty concentrating and fatigue.

SBS and BRI are frequently confused with each other. BRI usually entails a specific diagnosis of a set of symptoms caused by a specific environmental factor,

one that has developed into an illness that persists whether that factor is present or not. SBS refers to more general symptoms of malaise or discomfort, which are temporary and limited to time spent in the building. Conversely, BRI is often associated with a longer recovery time than SBS symptoms.

Particulate matter is the prime villain. The most lethal are the smallest particles (also known as PM2.5, for particulate

matter smaller than 2.5 microns in diameter, about one-third the diameter of a red blood cell), which are produced by combustion and household activities like cooking. These specks can get deep into the lungs, tarring the airways and weathering the heart, disrupting its ability to beat properly. Many studies have linked exposure to PM2.5 with heart attacks, cardiac arrhythmias, strokes, chronic obstructive pulmonary disease, worsened



symptoms of asthma and an increased risk of respiratory illness.

Worldwide, particulate matter contributes to about 800,000 premature deaths each year, according to the WHO, making it the 13th leading cause of death worldwide. Other pollutants also cause major problems, especially indoors—radon, a gas produced naturally in the Earth, is the second leading cause of lung cancer in the

US, and additional gases like carbon monoxide and volatile organic compounds (VOCs) cause innumerable health effects.

What are Indoor Air Pollutants and Where do They Come from?

There are many potential sources that lead to poor indoor air pollution with the most common being mold, radon, second hand tobacco smoke, smoke from burning wood, gas furnaces and various allergens. Volatile Organic Compounds (VOCs), formaldehyde, pesticides, lead and asbestos are also common sources of air pollution. Some of these items are naturally occurring, some are man-made and some depend on chemical reactions to occur under the right conditions.

What are the Strategies to Control Indoor Air Pollution?

Even though the factors that affect quality of indoor environment are

numerous, the good news is that most indoor environmental problems can be prevented or corrected. Achieving better IAQ in buildings requires proper application of science and technology. It calls for an optimum combination of proper buildings materials, effective ventilation systems design and indoor pollutant control mechanism.

Indoor air quality crosses economic status, race and ethnicity. Poor indoor air quality can be present at work, home, school or vehicles. Hence, this is a subject that needs to be addressed carefully for our present as well as future well-being. ■

Ashish K Jain

Partner,

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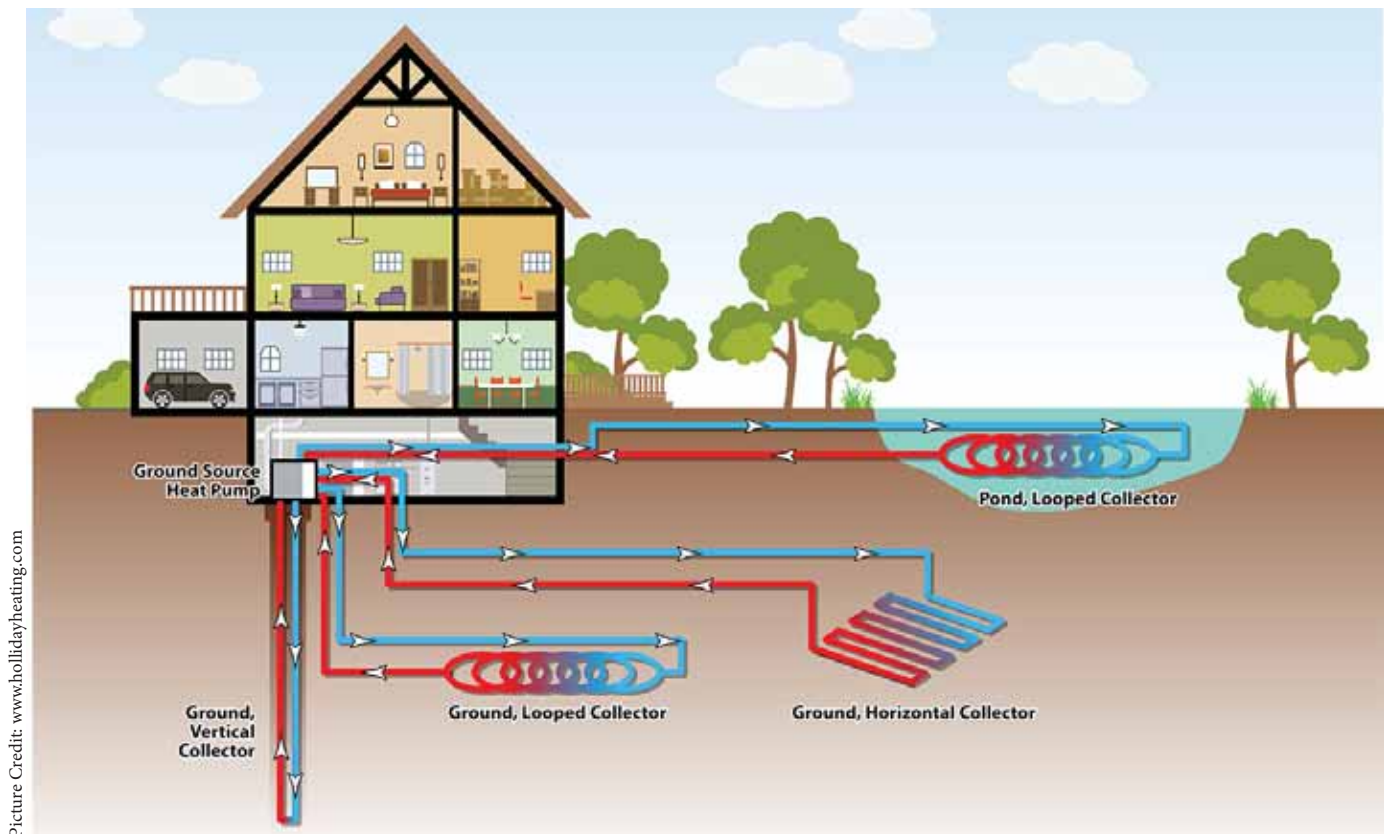
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Geothermal Heat Pump Prospect for Sustainable Development

(Part 3)

The article discusses various types of heat exchanger designs, features, and the characteristics of heat pump system tested. It looks in more detail at the applications of the technology, distribution systems, and the thermal performance of heat pumps. Geothermal heating can be more efficient than electric resistance heating.



Picture Credit: www.holidayheating.com

The earth's surface acts as a huge solar collector, absorbing radiation from the sun. In the UK, the ground maintains a constant temperature of 11-13°C at 30 metres below the surface all the year around. Among many other alternative energy resources and new potential technologies, the ground source heat pumps (GSHPs) are receiving increasing interest because of their potential to reduce primary energy consumption and thus, reduce emissions of greenhouse gases.

Direct expansion GSHPs are well suited to space heating and

cooling and can produce significant reduction in carbon emissions (Figure 1). In the vast majority of systems, space cooling has not been normally considered, and this leaves ground-source heat pumps with some economic constraints, as they are not fully utilised throughout the year. The tools that are currently available for design of a GSHP system require the use of key site-specific parameters such as temperature gradient and the thermal and geotechnical properties of the local area. A main core with several channels will be able to handle heating and cooling simultaneously,

Compressor _____

Heat exchanger _____

Active charge control _____

Basement _____



Figure 1: A photograph showing the connection of DX GSHP installed at the School of Built Environment

provided that the channels to some extent are thermally insulated and can be operated independently as single units, but at the same time function as integral parts of the entire core. Loading of the core is done by diverting warm and cold air from the heat pump through the core during periods of excess capacity compared to the current needs of the building. The cold section of the core can also be loaded directly with air during the night, especially, in spring and fall when night times are cooler and day times are warmer. The shapes and numbers of the internal channels and the optimum configuration will obviously depend on the operating characteristics of each installation. Efficiency of a GSHP system is generally much greater than that of the conventional air-source heat pump systems. Higher COP (coefficient of performance) is achieved by a GSHP because the source/sink earth temperature is relatively constant as compared to air temperatures. Additionally, heat is absorbed and rejected through water, which is a more desirable heat transfer medium due to its relatively high heat capacity.

The GSHPs in some homes also provide:

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

The GSHP is called such, because it pumps heat. Through the use of a simple, yet tried and tested refrigeration system, it pumps heat from the warm earth in the winter and places it in homes or businesses. In the summer time, the process is reversed. Since it costs far less to move heat than to make it, much less energy is consumed. This results in huge reductions in energy costs and greatly reduces the environmental impact of space conditioning. For closed loop systems, water or an anti-freeze solution is circulated through plastic pipes buried beneath the earth's surface. During the winter, the fluid collects heat from the earth and carries it through the system and into the building. During the

summer, the system reverses itself to cool the building by pulling heat from the building, carrying it through the system and placing it in the ground. Open systems operate on the same principle as closed loop systems and can be installed where an adequate supply of suitable water is available and open discharge is feasible. Benefits similar to the closed loop system are realised:

- Requires less mechanical room space.
- Requires less outdoor equipment.
- Does not require roof penetrations, maintenance decks or architectural blends.
- Quiet operation and reduces operation and maintenance costs.

Limitations

- Requires surface area for heat exchanger field.
- Higher initial cost.
- Requires additional site co-ordination/supervision.
- Higher design cost.

Heat Pump Types

There are various types of ground source heat pumps

Air source heat pumps (ASHP)

Air source heat pumps convert the energy created by the outside air into heat, giving a comfortable temperature inside the home and reducing heating costs by on average 50 per cent compared to traditional systems. Exhaust air heat pumps provide hygienic air inside the home, whilst capturing heat energy from lighting, people and domestic appliances, and recycling it. As with all heat pumps, air source models are most efficient when supplying low temperature systems such as under-floor heating. It can extract heat from the air even when the outside temperature is as low as minus 15° C. An air source heat pump system is compact and requires no storage space for fuel.

Ground source heat pumps (GSHP)

The GSHPs take heat from the ground rather than the outdoor

air. In winter, the ground is usually warmer than ambient air temperature. There is more heat available from the ground to pump into the house, reducing the need for auxiliary heat. So, a GSHP may be significantly less expensive to operate over the course of the year. In cold climates where winter air temperatures are too low for air-source heat pumps to be effective, GSHPs may be the most practical heat pump application (Figure 1). A properly installed GSHP may last longer than an air-source heat pump. It causes less wear on the compressor because it operates over a narrower range of temperatures, following more uniform ground temperatures throughout the year. Furthermore, the GSHP does not need defrosting, resulting in improved operating efficiency. There are, however, three main disadvantages:

The first is the initial cost. The GSHPs typically cost more to install than air-source heat pumps. Unless one has a large house with a large heating load, the energy savings might not offset the additional installation cost during the lifetime of the heat pump.

The second disadvantage is that it is difficult to find a qualified installer in the area and there may be a long wait when the system emergency service is needed. There are few installers because most installations require unique designs. For example, sites must be carefully evaluated for soil temperatures, moisture levels and heat conductivity. This is important, as the system must be designed to keep the soil near the house from freezing when the heat pump extracts heat from the ground.

The third disadvantage is that installation requires some excavation or drilling. Some systems require extensive trenching and expensive landscape repairs. Others are installed with a drill in a fairly stationary location, causing less damage. Additionally, it can be expensive if the underground piping requires repair, and the landscaping options may be reduced.

A basic description of the component parts of the heat pump is given below:

- Electrical input and controls: The system will be requiring an electrical input energy, three-phase being preferred, but single phase is perfectly adequate for smaller systems. A specialised controller is required to provide temperature and timing functions of the system.
- The heat distribution system: This is either underfloor heating pipes or conventional radiators of large area connected via normal water pipes.
- A heat pump packaged unit: DX GSHP type (approximate the size of a small fridge).

Water source heat pump (WSHP)

Water-source heat pumps use a body of water for their heat source. They typically use well water, but sometimes they use lakes or streams. Water source heat pumps – particularly, those using well water - have the same advantages as GSHPs. The water they use is usually warmer than winter air and temperatures are more stable.

Water-source heat pumps also share a disadvantage with GSHPs - they are more expensive to install than air-source systems (unless an existing well can be used) and may not

recover this additional expense unless the house has a large heating load. Hence, water source systems should be carefully evaluated in light of the following points.

- If the water-source is a stream or lake, then check if it is legal to use it as a heat source. Some areas have environmental laws that prevent this use of water (or have restrictions that make it more expensive), as the water gets too cold to use in the winter.
- If the water-source is a well, then it should have adequate flow and temperature to meet the heat pump requirements.
- Some localities require disposing the water via the sewer, which can increase the sewer bill. Others may require having a second well to return the water to the aquifer.

Heat Pump Features

The heat pumps have the following features:

Supplemental heat lockout

Outdoor thermostats sense the outdoor temperature and lock out the use of secondary heating devices (supplemental heat) unless the temperature drops below a preset point (except when the heat pump is not working and needs emergency heat). The advantage of this strategy is that it is a positive lockout that will not be defeated by 'thermostat fiddlers'.

Smart thermostats

Smart thermostats (microprocessor controlled) sense only the indoor temperature. They will not turn on supplemental heat unless the heat pump is unable to keep the house at the desired temperature. The advantage of this strategy is that it is tied to indoor comfort. There is considerable debate about which is the better strategy. But either one is clearly better than no lockout at all.

Staged supplemental heat

Most heat pumps have controls that cause all of the supplemental heat to be on at the same time. However, there are important benefits to staging supplemental heat. Staging refers to turning the supplemental heat on in two or more stages. The first stage comes on in mild temperatures just below the heat pump balance point. If the temperature falls below a point that the first stage is not enough, the second stage provides more heat. There are two important benefits of staging supplemental heat. First, more comfortable and second, it benefits utility ratepayers. One of the major costs of operating an electric utility is the cost of 'peak' power as defined by a high point of electrical customer demands. This peak occurs during the winter when lots of heating systems need power. By staging the backup heat, the utility's peak is likely to be lower, reducing utility operating costs. These savings are particularly important when they can help to avoid the cost of expensive new electrical generating facilities. Depending on the control system, staging supplemental heat may reduce the on/off cycles of the heat pump. Reduced cycling can increase the longevity of the heat pump.

Defrost control

There are many types of defrost controls. They can be grouped into two categories. First, time and temperature and,

second, is demand. Time and temperature controls turn on the defrost cycle at specified intervals whenever the outdoor temperature reaches a predetermined point. It is assumed that below a certain outdoor temperature there will be frequent frost formation and defrost will be necessary. Unfortunately, this can result in unnecessary defrost cycles, which waste energy. There may not actually be frost during the times specified. Demand controls actually detect the presence of frost on the outdoor coils. When the controls sense frost, they initiate the defrost cycle. When the frost is melted, the defrost cycle is terminated. Since the defrost cycle is only used when needed, this is much more efficient and reduces heating costs.

Emergency heat indicator

The terms 'emergency heat,' 'auxiliary heat' and 'supplemental heat' are often used interchangeably, since they all refer to the heating unit(s) that add to, or take over from, the heat pump when needed. Manufacturers are understandably reluctant to put a light called 'emergency heat' on their equipment, so the emergency heat indicator may have a different name. Nevertheless, a thermostat with an emergency heat light should be specified, even if it goes by a different name. A supplemental heat indicator, called 'auxiliary heat' indicator on some thermostats, tells when the supplemental heat is on. Unlike emergency heat, supplemental heat is a normal occurrence. It comes on when the heat pump alone cannot keep the house warm enough. The heat pump keeps working while the supplemental heat is on.

Safety switches

To prevent compressor damage, a heat pump should have pressure sensors that indicate either excessively high or dangerously low refrigerant pressures. If either condition occurs, the heat pump should automatically shut down, and switch on the emergency heat if needed. These adverse conditions are often accompanied by high temperature. Accordingly, those in the heat pump business often call these pressure/temperature switches.

Accumulator

Heat pump compressors are designed to compress gases, not liquids. Liquids are much more difficult to compress than gases. If liquid refrigerant enters the compressor, it may damage the compressor. Since compressors are very expensive to replace, heat pumps should be protected with an accumulator. The accumulator traps liquid refrigerant to prevent it from entering the compressor. However, scroll compressors are the exception to this rule as they can handle some liquid refrigerant without being damaged, so they do not require an accumulator.

Filter/drier

The filter/drier does two things: It filters the refrigerant to remove dirt and other impurities that can cause damage to the compressor and other heat pump parts. Also, it removes moisture from the refrigerant. Moisture can cause a variety of problems, so it is important to remove it from the system quickly.

Crankcase heater

When the heat pump is off during cold weather, liquid refrigerant can migrate to the compressor crankcase, reducing lubrication

effectiveness. When the heat pump comes on, the refrigerant evaporates rapidly. However, foam forms in the oil preventing adequate lubrication of the compressor and shorten its life. The compressor should be equipped with a crankcase heater, which prevents the refrigerant from liquefying in the oil. Most crankcase heaters are on at all times. Some are designed to operate only when needed. Again, the scroll compressor is the exception, as it does not require a crankcase heater to operate safely.

Salt air models

The outdoor unit may have a shorter life in coastal locations where salt air corrosion is a problem. Consequently, some companies manufacture outdoor units designed and built to resist salt air corrosion.

Types of Heat Pump Technologies

Characteristics of two types of heat pumps are summarised below:

Variable speed heat pumps

A long-awaited heat pump has just come on the market. It is called a "variable speed" heat pump because it adjusts its output to match the heating or cooling requirement of the home. This allows the heat pump to run continuously rather than starting and stopping frequently during mild weather. This is more efficient and reduces wear. It can also improve comfort since the fan speed is matched to the heat output, reducing drafts when the output is low.

Scroll compressor

Another recent development is a new type of compressor called a "scroll compressor". It has a rotary motion that reduces noise more than any other rotary compressors, due to its unique design. It has a higher efficiency at lower temperatures than reciprocating compressors for better seasonal heating performance. It also tolerates small amounts of liquid refrigerant, so it does not require an accumulator or crankcase heater.

Proper Sizing and Installation

It is difficult for the consumer to verify that the contractor properly sizes and installs the system, and they should at least let the contractor know the expected criteria to be met. If it is in a utility-sponsored heat pump programme, the utility may help ensure the system meets these criteria.

Heat pump sizing

There are three reasons that a heat pump should be properly sized for the house, cost, durability and efficiency.

Cost: Large equipment is more expensive. If the system is too large, too much money will be spent on it. On the other hand, if the heat pump is undersized for heating, supplemental heat will operate too often, increasing the electric bill.

Durability: Most wear and tear on a compressor occurs when it starts up. Oversized equipment will cycle on and off more often than accurately sized systems.

Efficiency: Oversized systems have shorter "on" times, which means a greater portion of "on" time is spent getting started, an inefficient part of the heat pump cycle.

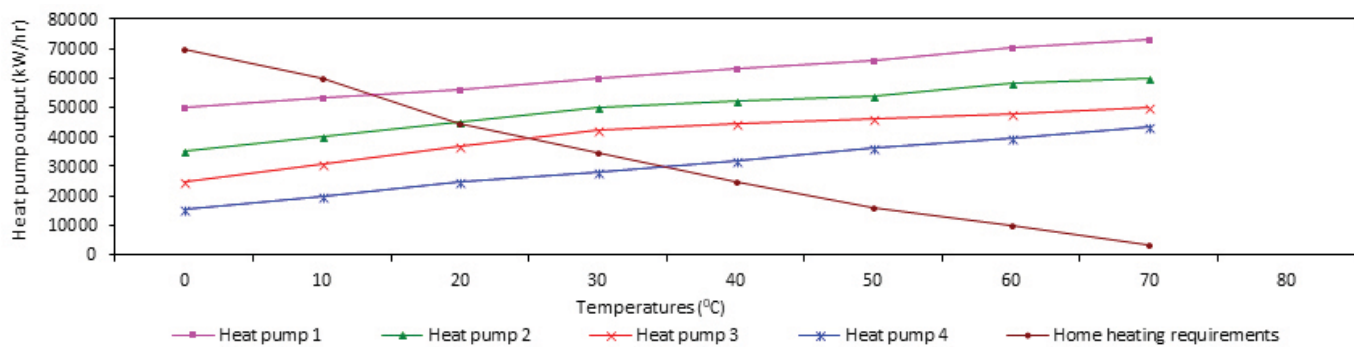


Figure 2: The relationship between the heating requirement of the house and the heat output of four hypothetical heat pumps

Load calculations

The only way to properly size a heat pump is to do heating and cooling load calculations and then match the equipment to the calculated loads. These load calculations should take the following into account:

- The dimensions of the floors, basement walls, above ground walls, windows, doors and ceilings.
- The energy efficiency of these components (insulation, window types, air tightness, etc.).
- Local weather: Loads should be calculated for a cold winter day (but not the coldest on record) and a hot summer day (but not the hottest on record). The local electric utility may be able to recommend appropriate design temperatures.

Load calculation methods

There are several widely accepted methods of calculating heating and cooling loads. The most popular are based on methods and data developed by the American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE). One of the best is called Manual Journal: Load Calculation developed by the Air Conditioning Contractors of America (ACCA). Manufacturers often simplify ASHRAE and ACCA methods so that the process can be speeded up. Most major manufacturers provide forms that help contractors' size their heating equipment. If the forms are based on ASHRAE or Manual Journal, the contractor will probably do a good job of estimating the sizing requirements.

Room-by-room load calculations

Load calculations should be done for each room in the house, because each room has its own heating and cooling requirement. It's the only way contractors know how much heating or cooling to deliver to each room. Otherwise, they can only guess at duct sizes, and deliver incorrect amounts of heating or cooling. Areas that are open to each other are treated as one "room". For example, one "room" could include kitchen, family and dining areas.

Sizing for heating and cooling

First, choose equipment that meets the cooling needs of the house. Then check the heat output of the equipment against the heating requirement "Choosing the best size for heating". If the heat output is too small, larger equipment can be chosen as long as it does not oversize the cooling load by more than 25 percent (some utility financing programmes allow 50 percent over-sizing).

When sizing for cooling, both sensible and latent cooling loads should be considered. Sensible cooling is most important, and it is the type of cooling people are familiar with - simply reducing the air temperature. Latent cooling is reducing the humidity so that occupants can be comfortable at the temperature they choose for indoor living. Since European summers are typically not humid, latent load is not as important. However, in general, equipment should be chosen to meet sensible plus latent loads. If the equipment matching the heating requirement is not available without over-sizing for cooling, then one of the following strategies may need to be considered:

1. Upgrade the insulation and windows and reduce the air leakage from the house to reduce the winter heating requirement; or
2. Choose a unit that is undersized for heating, realising that the supplemental heat will operate more than optimal, hence, reducing the potential savings.

Choosing the best size

Assume that the ideal heating unit in the climate has a typical balance point near -1.2°C . There is a range of 3 to 5 degrees on either side. Two heat pumps in the graph are close enough. The smaller heat pump has a balance point of 0°C , and the larger one, -2.7°C .

Figure 2 shows the relationship between the heating requirement of the house and the heat output of four hypothetical heat pumps. The four heat pumps are different sizes (they have different heat outputs), so the balance point occurs at different outdoor temperatures for each. This graph can help to choose the best heat pump for heating. None of the units give the exact balance point and the cooling load should be checked to see which one is acceptable. If the larger unit is outside the boundary of 125-150 percent of the cooling load, then the smaller unit would be chosen. If both were in the acceptable range for cooling, the larger unit would be chosen for increased heating economy.

The Duct Systems

The issues relating to the duct systems are summarised below:

Duct sizing

One of the most important aspects of proper installation is to ensure that the ductwork can deliver adequate airflows to maintain

comfort in the house. But even more importantly, the airflow needs to be adequate to prevent damage to the heat pump. Airflow must meet the manufacturer's specifications. Otherwise the refrigerant will not be able to get rid of excess heat. If the refrigerant gets too hot, its pressure may exceed the limits of the compressor and cause it to fail. Replacing a compressor is expensive; it costs more than the added cost of properly designing and installing the duct system.

Return air system

Most customers are aware of the warm air supply outlets because they deliver warm air to the house. And it is easy to figure out that there are usually ducts that connect the heat pump to those outlets. However, it is easy to overlook the return side of the system - the ducts and grills that carry air back to the heat pump. In fact, the return airside is often installed as though it's an afterthought. Ideally, there is a return grill and duct in each room where there is a warm air supply. That is usually expensive, but it is worthwhile to get as many returns as practical. At a minimum, there should be one for the main living areas and one for the bedrooms. It is also worth considering separate returns for large living rooms and master bedrooms. A good return air system can help reduce differences in pressure throughout the house, reduce drafts and improve comfort.

Terminals

Terminals are the registers, vents and grills at the ends of the ducts that deliver air to rooms or return air to the heat pump. Terminals should distribute conditioned air properly in each room of the house. The room-by-room heat load calculations mentioned earlier tell the contractor how much airflow each room needs.

Dampers

Adjustable duct dampers must be installed so airflow can be set for each room, according to the room-by-room heat load calculations. After the system is installed, the heating contractor should "balance" the system by adjusting each damper for

correct air flows. These dampers are usually found in branch ducts near where they take off from the main duct. Once the dampers have been adjusted to balance the system, they are usually not moved unless the system is modified.

Duct air sealing

Air leakage from ducts is typically one of the main sources of heat loss in the house. Ducts should be sealed at joints between sections, along seams in individual duct sections, and where ducts penetrate from unheated to heated areas. Ducts are typically sealed with duct tape. Aluminum tape is more durable than cloth varieties.

Duct insulation

Ducts passing through unheated areas such as garages, crawl spaces and attics should be insulated. Northwest regional conservation standards require sheet metal ducts to be insulated with R-11 insulation and insulated flex duct with two layers of R-4 or one layer of R-11 insulation.

Flexible duct

Some contractors use flexible ducts with insulation already built in. Because flexible ducts can be installed by less experienced trades' people than required by sheet metal ones, there is some concern that flexible ducts encourage poor installation practices. However, flexible ducts should be installed according to the following guidelines.

1. Use R-11 or "double wrap" ducts (two layers of R-4).
2. Make all bends gradual so airflow isn't restricted.
3. Make connections between sheet metal and flexible ducts with metal or nylon clamps.
4. Seal connections (aluminium duct tape) between flexible and sheet metal ducts.
5. Support flexible ducts so they do not sag (restricting air flow) using supports at least 2.5 cm wide.
6. Stretch duct to its full length so air passages are as smooth as possible.

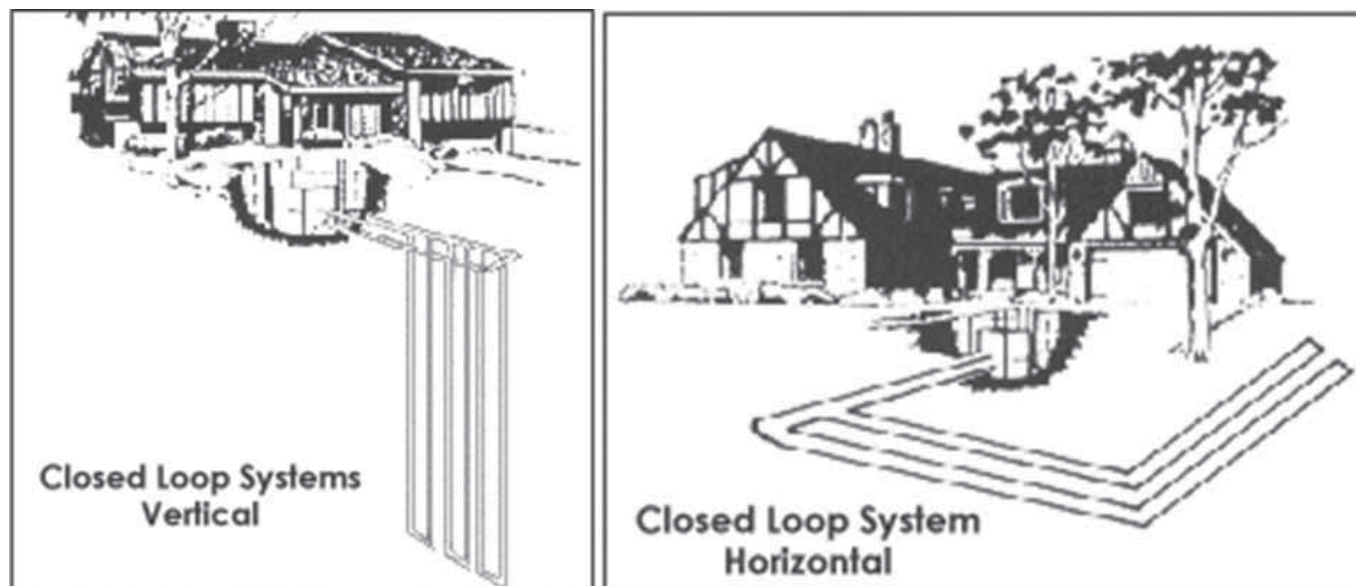


Figure 3: Ground loops can be installed vertically or horizontally in the ground

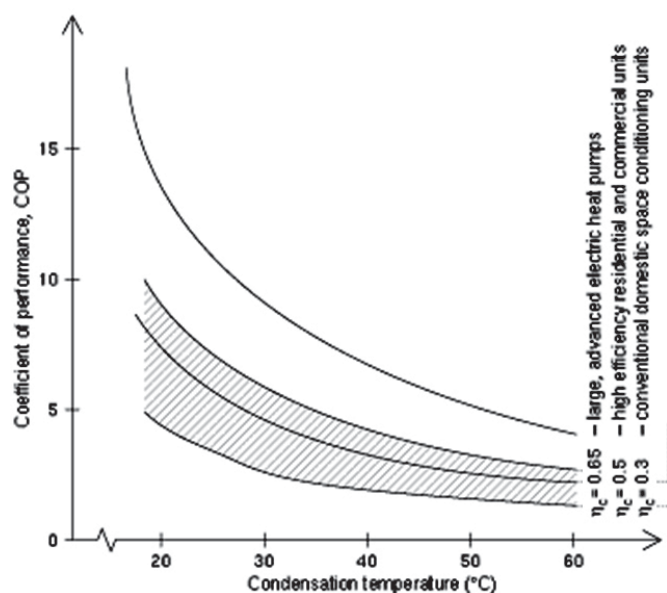


Figure 4: COP

Design, Construction and Operational Issues of GSHPs

The most economical application of GSHPs is in buildings that require significant space and water heating and cooling over extended hours of operation. Examples are retirement communities, multi-family complexes and schools. Building types not well suited to the technology are retail shopping malls, office buildings and other buildings where space and water heating loads are relatively small or where hours of use are limited. A typical seasonal performance factor for a GSHP system with an electrically driven vapour compression cycle heat pump is 3.0 and high efficiency, heating only heat pumps can give seasonal performance factors of 3.8. The highest seasonal performance factors are for systems with horizontal collectors with direct circulation supplying low temperature heating systems, for which seasonal performance factors often exceed 4.0 and are expected to reach 5.0 in the near future (Figure 3).

The COP of a heat pump is closely related to the temperature

lift, i.e., the difference between the temperature of the heat source and the output temperature of the heat pump. The COP of an ideal heat pump is determined solely by the condensation temperature and the temperature lift (condensation - evaporation temperature). Figure 4 shows the COP for an ideal heat pump as a function of temperature lift, where the temperature of the heat source is 0°C. Also shown is the range of actual COPs for various types and sizes of real heat pumps at different temperature lifts.

Conclusions

Heat pumps can offer the most energy efficient way to provide heating and cooling in many applications, as they can use renewable heat sources from the surroundings. Even at temperatures considered to be cold, air, ground and water contain useful heat that is continuously replenished by the sun. By applying a little more energy, a heat pump can raise the temperature to the required level. Similarly, heat pumps can also use waste heat sources such as from industrial processes, cooling equipment or ventilation air extracted from buildings. A typical electrical heat pump will just need 100 kWh of power to turn 200 kWh of freely available environmental or waste heat into 300 kWh of useful heat. Because heat pumps consume less primary energy than conventional heating systems, they are an important technology for reducing emissions of gases that harm the environment, such as carbon dioxide (CO₂), sulphur dioxide (SO₂) and nitrogen oxides (NO_x). However, the overall environmental impact of electric heat pumps depends also on how the electricity is produced. Heat pumps driven by electricity from, for instance, hydropower or renewable energy reduce emissions more significantly than if the electricity is generated by coal, oil or gas fired power plants. ■

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Maersk Line Adds a Feather to its Cap

Maersk successfully completes first mile service for imports of refrigerated apples saplings from Verona, Italy to Sonapat, India



Maersk Line, the global containerised division of the Maersk Group, has successfully executed first mile service for imports of live apple saplings from Verona, Italy to Sonapat, India for leading importer of apple saplings.

Maersk Line is dedicated to delivering the highest level of customer-focused, reliable ocean transportation services. This was a first ever store door of reefers handled successfully by Maersk Line where Intermodal transportation, custom clearance and documentation at origin was seamlessly executed.

Maersk Line is committed to provide their global partners an innovative solution and ease of doing business when it comes to logistical support specially for reefer cargo.

With the successful shipment of apples saplings, Maersk Line has achieved yet another milestone of delivering one stop logistics solution when it comes to perishable cargo.

In the past one year, Maersk Line has enabled movement of multiple consignments of complex cargo out of India successfully. Due to its global presence and network, the exporter network of India has been able to successfully reach out to newer geographies.

Commenting on the occasion, Steve Felder, Managing Director, Maersk Line (India, Sri Lanka, Bangladesh, Nepal, Bhutan and Maldives) said, "We always help our partners throughout the globe in seamless logistical integrated solutions. This too is in the same direction and is a testimony to the complete set solutions we provide to our partners. This cargo was highly perishable and hence it was essential to leverage our reefer expertise in delivering

the best logistical solution here to the client. We will continue to work with partners across the globe to provide the best SD reefer solutions which would be mutually beneficial."

Steve Felder further added, "In the past 18 months or so, we have expanded our horizon in various new commodity categories. India is at an

exciting growth path and with our focus on adding value to the customer's end-to-end cold chain, the commitment to support the growth of the trade is very strong and visible. Whether it is a small local start-up planning big or a large multi-national entering a new market, we enable trade and growth by being closer to your business and developing solutions to suit the specific needs of the cold segments."



"India is at an exciting growth path and with our focus on adding value to the customer's end-to-end cold chain, the commitment to support the growth of the trade is very strong and visible."

Integrated BMS for Healthcare Building

Air conditioning requirement in hospital building is different than any commercial building. Some areas need 24 hours AC, whereas some areas need 12 or 8 hours. In fact, some consultation rooms need AC only for few hours. IBMS helps in providing uninterrupted AC supply in different times as well as it helps in reducing energy bills for AC.



Healthcare facilities are the basic requirements of human beings. Among the growing nations, India is a country where healthcare is in very bad shape. With introduction of various health insurance service providers, people are ready to visit the private hospitals now-a-days. Keeping good healthcare, cleanliness and advance healthcare

technique in mind, healthcare developers are now coming up with good hospitals as no market is required for a hospital business. People may not have choice for emergency but for proper treatment, they prefer to go to a hospital having better equipment and doctors. The healthcare facility providers are also ready to invest in a world-class facility which will not only

treat the patients but also generate revenue.

Functioning of Hospital

The operation and well-functioning of any healthcare units are much more important than setting up the units. Once a hospital starts functioning, no compromise can be done on its services as then the life of human beings is at risk. Integrated



Detail Functioning of IBMS

Solution

Stage 1 – Information Management

- Centralised Monitoring System
- Integrated Management Server

Stage 2 – Building Automation

- Building Management for individual locations
- Access Control using RFID Reader
- Monitoring and tracking of activities using IP/CCTV surveillance cameras
- Public Address Systems to alert the occupants in the premises
- Fire Alarm Systems to alert occupants from fire hazards

Stage 3 – Perimeter Security

- Perimeter surveillance using CCTV/IP cameras
- Visitor Management
- Vehicle Access Control

Stage 4 – Automation of all types of building services

- Visitor Management
- Vehicle Access Control.

While, stage 1, 2, 3 are basically covered by system providers and widely addressed by integrators, stage 4 which takes care of all major building services and helps in energy management, are not given importance which resulted in heavy energy bills and problem in basic day-to-day operations. Here, we will discuss how building services can be connected to IBMS and how it will benefit the health care developer.

IBMS for Building Services

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connected with one central point for a common goal, it will be known as Integrated Building Management System. Design engineers take care at each stage to select right equipment for saving energy as below:

- Chillers and pumps- Timing, temperature control.
- LED fixtures- Timer based or sensor-based control.
- DG Back – Auto change over, Diesel stock level and billing control.
- VFD in pumps, AHUs- for reducing running cost.
- Water saving fixtures – monitoring and mal functioning of fixtures
- STP - working condition, municipality alert and land scape water distribution.
- CO and CO₂ sensors in corridors, basements will help in increasing indoor air quality.

There are lot many mechanical and electrical equipment not listed above which are found in any healthcare building and can be optimised for power and water saving. But, the main objective will fulfill only with the help of IBMS. For a 350-bed hospital, nearly three lac units of electricity can be saved per month with simple IBMS without compromising on services. Life of HVAC system can be increased by five to six years.

All the building management system is based on some system platform and others need to get connected to that platform. RS 485 port is a common port which enables other equipment to get

connected with IBMS easily.

Beyond energy saving, there are other advantages of IBMS from healthcare prospective.

- **Air Conditioning:** Air conditioning requirement in hospital building is different than any commercial building. Some areas need 24 hours AC, whereas some areas need 12 or 8 hours. In fact, some consultation rooms need AC only for few hours. IBMS will help in providing uninterrupted AC supply in different times as well as it will help in reducing energy bills for AC.
- **Filters:** Hospital HVAC system has different filter banks of minimum MERV 12 level to hepa. Proper IBMS will help the filter status updated every moment.
- **Heating** requirements to some particular rooms can also be easily monitored and controlled by IBMS.
- **Auto ventilation of ICUs and NICUs:** All isolated rooms will be auto ventilated with exhaust units automatically once patient get changed. CO₂ level in these rooms will also be monitored by IBMS directly.
- **Consulting rooms** will have volume variable frequency drives and CO₂ sensors. If both are connected with IBMS, ventilation rate can be controlled and running cost can be saved as units will not be running for unoccupied time.
- All the indoor air conditioning units have thermostat which get connected




to IBMS and dampers. This way thermal control becomes easy.

- **On timing of the function** of operation theaters, IBMS will put an auto cleaning of air program where the exhaust system of the OT will run in exhaust mode. Same units can be reworked on 100 per cent fresh air mode.
- **Electrical:** IBMS will always help in lighting controls sensors by using of daylight thus, reducing in energy bills.
- **DG:** Starting from automation to running status will be monitored by BMS. It will give a history of power failures.
- **Security systems** are entirely connected in IBMS which enhance the modern security.
- **Doctor on call** systems are also get connected in IBMS and its status and history get stored.
- **Nurse calling system** gets connected with IBMS for record and history of the requirements.
- **Biometric** and card-based access system in integration with IBMS will give actual location of each individual.
- **Hot water system** and solar hot water line sensors are also connected with IBMS for actual status on functioning of the system. ■

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BELIMO Sensors Perfect Complement to Actuators & Valves

To achieve a good room climate and energy efficiency in heating, ventilation and air conditioning plants reliable field devices such as actuators, control valves, and sensors are required. While actuators and valves control flows of air and water, sensors measure temperature, humidity, pressure, air quality or flows. They are installed in rooms, air ducts or pipes.

Sensible expansion of our range

Belimo has many years of experience in developing high-quality sensors for the HVAC industry that assure the reliable recording of information and guarantee the best possible data quality. We are expanding our core business of components with integrated sensors by



adding autonomous sensors that can be applied to any system design. Belimo's complete product range of sensors is optimally tailored to Belimo actuators and valves that can be seamlessly integrated into existing or new building automation systems.

Innovation in detail

For instance, the new air quality sensor measures CO₂ content with two channels to compensate for possible deviations. That means greater accuracy and long-term stability. In addition, the

same device also records humidity and temperature values and feeds the data into the system through just one bus interface. As a result, installation and integration costs can be reduced.

Email: info.india@belimo.ch

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The FLIR C3 is a full-featured, pocket-sized thermal camera designed to be go-to tool for electrical or mechanical and building applications. It is able to find hidden hotspots, structural defects, plumbing issues, and more. The C3's must-have features include MSX real time image enhancement, area maximum or minimum temperature measurement, and Wi-Fi connectivity – so user can quickly get to the job of finding hidden problems, sharing images, and documenting repairs.



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Mitsubishi Electric Trane HVAC US LLC Introduces DC-8000 Controller

Mitsubishi Electric Trane HVAC US LLC (METUS), a leading manufacturer of Zoned Comfort Solutions and Variable Refrigerant Flow (VRF) cooling and heating systems, introduces the DC-8000 Controller, a compact, internet ready controller and server platform, as part of its Diamond Controls Solutions offering.

The DC-8000 Controller is built with Niagara4 technology, the latest version of Tridium's Niagara Framework, for optimum performance. The new interface and platform takes advantage of the Internet of Things, including advanced visualisation and new search, security and navigation tools.

Developed to provide integrated control, supervision, data logging, alarming, scheduling and network management, the DC-8000 connects multiple, diverse devices and sub-systems. The controller is ideal for any size facility, allowing for



integration and control of multiple systems within a building, including HVAC, lighting or carbon monoxide detectors, among others. Multiple DC-8000 controllers can be applied together in larger facilities, multi-building applications and large-scale control system integrations. Coordinated usage with the DC-Pro4 allows the controllers to aggregate information, including real-time data,

history and alarms to create a single, unified application.

"The features and updates involved in this new technology put it light years ahead of its predecessor, the DC-600, as it offers more advanced integration opportunities," said Charles Miltiades, Director of Controls Products & Solutions for Mitsubishi Electric Trane HVAC US. "We are constantly monitoring trends and customer demands and striving to deliver the most effective solutions possible."

Email: www.mehvac.com

First Apple Homekit-Compatible Air Conditioners from GE Appliances

Owners of iPhone and iPad can beat the heat with Apple HomeKit-connected window air conditioners from GE Appliances. Delivering 8,000 to 12,000 BTUs to cool medium to large sized rooms, the units are the first HomeKit-compatible air conditioners available for the US market. GE Appliances is the first US-based appliance manufacturer to introduce a product line that works with HomeKit. Now, Apple's popular home automation platform can combat rising temperatures with advanced comfort control.

A Cool Connection

By adding these units to the Apple Home app, users can demand refreshing cold air with a simple tap or by asking Siri. Owners can also create automations to instruct a unit to perform certain actions, such as turning on or off at a certain time of day. Units can also be controlled remotely, even outside of the home. No matter what scenes owners choose to set up, it is easy to program a custom cooling schedule that works for each home.

How it Works

Inside the home, owners of GE Appliances' connected air conditioners can operate the unit from the Apple Home app on iPhone, iPad, iPod touch or Apple Watch by using Siri on any



device including HomePod or directly from Control Center. Outside the home, owners need a HomeKit home hub (HomePod, 4th generation Apple TV or an iPad with the latest version of iOS to remotely control these units or set up automations.)

"Consumers told us they like how they can create their own schedules to keep rooms comfortable without wasting energy," said John Desmarais, Commercial Director, Window A/C,

Portables & Dehumidifiers for GE Appliances. "Many people also found peace of mind in having control of the unit anywhere they have internet access. We're pleased to offer the very first air conditioners with HomeKit integration, bringing simple and secure control through the Apple Home app and using Siri."

Other Features

These ENERGY STAR-compliant air conditioners allow owners to enjoy four-way air direction by selecting from three cooling settings or choosing energy saver mode, where the fan and compressor shut off automatically when the room is cool enough. An electronic digital thermostat and standard remote also make manual operation simple and intuitive, while installation is no worry. Meanwhile, a reminder light tells owners precisely when to replace the filter to keep their unit operating at optimal efficiency.

Forthcoming Events At A Glance

DairyTech India 2018

Venue: Bangalore International Exhibition Centre (BIEC)

Date: 31st August to 2nd September 2018

Website: www.dairytechindia.in

Food Logistics India

Venue: Bombay Convention & Exhibition Centre, Mumbai

Date: 27th to 29th September 2018

Website: www.foodlogisticsindia.com

Chillventa

Venue: Nuremberg, Germany

Date: 16th to 18th October 2018

Website: www.chillventa.de

Refcold India

Venue: Mahatma Mandir Convention Cum Exhibition Centre, Gandhinagar, Gujarat

Date: 22th to 24th November 2018

Website: www.refcoldindia.com

Company Name	Page No.
ALM Engineering & Instrumentation Pvt. Ltd.	IFC
ALMI International	9
Belimo Actuators India Pvt. Ltd.	7
CAREL ACR Systems India Pvt. Ltd.	13
Chillventa 2018	21
Embraco	23
Ensavior Technologies Pvt. Ltd.	BC
FLIR Systems India Pvt. Ltd.	15
Food Logistics India	17
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Highest Rated Platinum Certification for Azure Power HQ

Azure Power, one of India's leading independent solar power producers, announced that its headquarter in Aerocity, New Delhi has been awarded India's first Platinum Certification under the Leadership in Energy and Environmental Design (LEED) v4 Commercial Interiors rating system by the US Green Building Council (USGBC), a non-profit organisation that promotes sustainability in building design, construction, and operation.

The LEED Certification identifies Azure Power as a showcase example of sustainability and demonstrates leadership in transforming the building industry. The LEED Platinum Certification is the highest rated certification for recognising the best-in-class



building strategies and practices in green building.

Azure Power achieved LEED Certification for implementing practical and measurable strategies and solutions aimed at achieving high performance in the following categories: integrative process, water efficiency, energy use and atmosphere, materials and resources, innovation and indoor

environment quality. "Market transformation happens one building at a time. Azure Power understands the value of LEED and has exemplified extraordinary leadership in reshaping their sector," said Mahesh Ramanujam, President and Chief Executive Officer, USGBC and Green Business Certification Inc (GBCI). ■

World's Largest Undersea Tunnel Reduces Environmental Impact

Eurotunnel's sustainability efforts boosted with completion of new cooling system in landmark Channel Tunnel that delivers energy savings of at least 33 per cent or 4.8GWh per year. Eurotunnel released official data demonstrating energy savings of 33 per cent after the first season of operating a new cooling system for maintaining requisite temperatures in the landmark Channel Tunnel. The operator saved 4.8 GWh and approximately € 500,000 in 2017 courtesy of the new cooling system – equivalent to saving enough electricity to run 1,000 households. The newly released data from the operation of the new cooling



system will dramatically boost Eurotunnel's sustainability efforts which have been recognised with its fifth consecutive certification from the UK's Carbon Trust Standard for a further nine per cent decrease of its carbon footprint in 2015-2016 compared to 2012-2013.

"Eurotunnel's commitment to environmental protection involves a number of initiatives. We saw the replacement of the Channel Tunnel cooling system as a chance to reduce our energy consumption and carbon footprint," said François Gauthey, Deputy Chief Executive Officer of Getlink, Channel Tunnel owner. ■

RMZ Corp Goes Green

RMZ Corp's, RMZ Ecoworld's four campuses have been accorded the LEED Gold certification for the implementation of sustainable development, making RMZ Corp the owner of largest LEED certified portfolio under Arc platform in India. Mahesh Ramanujam, CEO and President, USGBC and GBCI presented the certificates to Thirumal Govindraj, Managing Director of RMZ Corp.

Govindraj, Managing Director, Executive Management, RMZ Corp, said, "With every step, we take towards the future, we leave footprints that have a significant impact on our environment. This accolade further reinforces our commitment to incorporate the best sustainable practices and state-of-the-art green features in our developments. This is what fuels our quest to break new ground in sustainable innovation."

"Market transformation happens one building at a time. RMZ



Corp understands the value of LEED and has exemplified extraordinary leadership in reshaping their sector," said Mahesh Ramanujam. ■

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- Extremely easy operation
- Life of more than 15 to 20 years

**Over 300
installations**

Typical case study data of a 1200 TR Chiller

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



Mist Resonance Engineering Pvt. Ltd.

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... A Green Approach To Energy Efficiency & Sustainability In HVAC Systems

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Let's Solve Water

Pumps & Package Pumping System on Variable & Constant Speed

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- **Lowara:** Water & Waste water pumps (Hydro-pneumatic Booster, Submersible, Drainage Pumps).
- **Flygt:** Submersible Pumps, Mixers and Mechanical Aeration equipment.
- **AC Fire Pump:** UL/FM approved Fire Pumps and skids.



FlowCon international

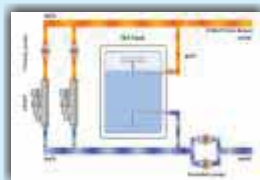
PICV & Automatic Balancing Valves

Key Features

- Continuous Display of Flow Rate
- LCD Display
- Optional Fail-Safe Power Storage Feature
- Communication with BMS thru RS-485
- BACnet Compatible
- 51 Different Maximum Flow Rate Settings
- 100% Valve Authority
- ◆ Pressure Independent Control Valves
- ◆ Adjustable Cartridge Automatic Balancing Valves
- ◆ Pre-set Automatic Balancing Valves
- ◆ Temperature Control Valves
- ◆ 3 Way By-Pass Modules
- ◆ Externally Adjustable Automatic Balancing Valves
- ◆ Thermostatic Control Valves



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Chilled Water Thermal Energy Storage System

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.

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- Energy Savings
- Maintenance Savings
- Improved Indoor Air Quality
- Faster Return on investment



ESPAIR™

Electrostatic Precipitation System



Key Features

- Removal of grease and smoke from commercial kitchens
- Removal of smoke, fumes and oil/coolant mist from industrial processes
- Higher efficiency, upward of 90-95% in single stage, more than 99% in multi stage
- Very low pressure drop in comparison to media and cartridge filters

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