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Cooling India

India's foremost Monthly dedicated to the growth of HVACR Industry

A Chary Publication

Publisher's Letter

Hello and welcome once again to *Cooling India*. It is that time of the year in India when soaring temperatures in many parts of the country has caught even expectant weather scientist by surprise. Some parts of the country, especially in the central and northern belt mercury reading recorded a daze-inducing heat of 47°C. In fact, the national capital suffered blazing heat. However, things have improved a bit since yesterday, when I started writing this with thunderstorm and dust storm hitting the city.

Since more than 100 people have lost their lives in the past 15 days due to soaring heat waves across northern India, I would like to dedicate this note for some basic methods of keeping our place of residence cool even without air conditioning, which is still considered a luxury by a vast majority of our population. I would urge you to share this with those who are in need. For those majority of the people who do not use air conditioning, there are many ways and methods to keep your house reasonably cool in the dry summers that we have in India. There are two major heat receptors in any building - the roof and the wall. Most of our buildings are made of concrete and therefore it absorbs in the heat and radiates it to the lower floors and similarly from the walls the heat transfer occurs directly to the rooms. Apart from that in many houses the temperature of the room increases because of clutter of furniture that create a hot air pocket and in some because of the dark colours used on the walls, curtains and furniture.

Paint your building roof in white so that the heat is radiated back. Use as much of neutral light colours inside the room, like light colour curtains and wall paints. Keep the windows open for fresh air to come in. And last but not the least, why not have lots of plants in and around our homes.

Whichever way you choose to keep yourself cool from the soaring heat, stay safe and wish and hope monsoon hits our shores soon. Hope you enjoyed reading this issue as much as we have in putting together the different contents for you. Do send in your comments to me at pravita@charypublications.in.

Pravita Iyer
Publisher & Director

Directors
Mahadevan Iyer
Pravita Iyer

Publisher
Pravita Iyer
pravita@charypublications.in

Editor-in-Chief
Mahadevan Iyer
miyer@charypublications.in

Associate Editor
Supriya Oundhakar
editorial@charypublications.in

Advertising Manager
Nafisa Kaisar
nafisa@charypublications.in

Design
Nilesh Nimkar
charydesign@charypublications.in

Subscription Department
Priyanka Alugade
sub@charypublications.in

Accounts
Dattakumar Barge
accounts@charypublications.in

Response Department
Sonali Pugaonkar
mktg@charypublications.in

Digital Department
Ronak Parekh
dgmarketing@charypublications.in

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Chary Publications Pvt. Ltd.
906, The Corporate Park, Plot 14 & 15,
Sector - 18, Vashi, Navi Mumbai - 400 703.
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Whirlpool Confirms Embraco Sale

Whirlpool Corporation announced that it has entered into an agreement to sell the company's Embraco compressor business to Nidec Corporation for a cash purchase price of $1.08 billion, subject to customary working capital and indebtedness adjustments. The transaction is expected to close in early 2019, subject to regulatory approvals and other customary closing conditions.

"We are proud of our strong portfolio of global consumer brands. Since Embraco operates in the business-to-business space, this transaction enhances our strategic focus on investing in and growing our consumer-facing business," said Marc Bitzer, Chief Executive Officer of Whirlpool Corporation. "The planned tender offer further demonstrates our commitment to returning capital to shareholders, consistent with our balanced capital allocation strategy."

Headquartered in Brazil, Embraco has been a Whirlpool majority-owned business unit since 1997. The business has a workforce of approximately 11,000 employees across eight global manufacturing facilities located in Brazil, Italy, China, Slovakia and Mexico. Embraco also maintains commercial offices in the United States and Russia. The Embraco business is currently reported as part of Whirlpool Corporation's Latin America segment. In fiscal year 2017, Embraco contributed approximately $1.3 billion to Whirlpool's net sales with margins approximating the segment average.

The transaction is not expected to have a material impact on Whirlpool Corporation's 2018 financial results. As previously announced, Whirlpool expects to cease operations and end production at Embraco's Italy facility, which is subject to a separate agreement with local authorities and unions. Therefore, the Embraco Italy facility is not included in the sale to Nidec Corporation. ■

New Research Reveals Benefits of Thermal Energy Storage

Ingersoll Rand, a world leader in creating comfortable, sustainable and efficient environments, engaged with Western Cooling Efficiency Center at University of California, Davis, on research that shows thermal energy storage can provide significantly greater benefits to utilities and electricity grid operators than previously thought.

"This study will help utility companies and building operators optimize resource planning and energy use by capturing the full value of thermal energy storage, which uses an energy storage tank and ice to shift cooling needs to off-peak, night time hours," says Scott Tew, from Ingersoll Rand's Center for Energy Efficiency and Sustainability, which co-sponsored the study.

The research project: Valuation of Thermal Energy Storage for Utility Grid Operators, demonstrated that the current method for estimating the electrical grid impact of Thermal Energy Storage systems does not fully consider the impact of energy savings that occurs during the hottest days of the year, which means that estimates are far lower than previously thought. By basing estimates on a "10-day average baseline," the data drastically under-estimates the impact of disconnecting the cooling system from the electric grid when temperatures outside are very hot and the grid reaches its peak load conditions. The current method under-predicts its impact on the electric grid by as much as 77%, between 38% and 57% on average, and by a minimum of 3%. The current method does not adequately account for shifts in building loads due to holidays, weekends or extreme events, when thermal energy storage can save the most energy by disconnecting cooling from the grid. ■

CoolSys Acquires Axiom Energy Solutions

CoolSys, a parent of market-leading refrigeration and HVAC companies nationwide, announced it has acquired Axiom Energy Solutions as the newest member of the CoolSys family of companies. With this acquisition, CoolSys will integrate the resources and capabilities of Axiom as a leading provider of energy efficiency solutions with CoolSys Energy Solutions to serve energy optimization (EO) customers nationwide. Both companies are widely known for their expertise and services within the retail grocery sector.

"Our acquisition of Axiom combines the power of two of the industry's leading EO companies together into one unified energy solutions business that broadens our services portfolio and the value we bring to our customers across multiple market segments," comments Adam Coffey, President and CEO of CoolSys. "Our acquisition of Axiom is just the beginning of the investments that we plan to make in bringing expanded capabilities to our CoolSys Energy Solutions customers."

Founded by Anthony Tippins, Axiom is a well-established provider of energy efficient equipment and technology solutions. The firm engineers customized solutions to address the energy, sustainability and compliance needs for companies across a range of industries including supermarkets, non-food retail, convenience stores, hospitality, healthcare and education.

"The entire Axiom team is thrilled to become part of the CoolSys family," Tippins comments. "We have respected the energy-related work they have done in the market for years, and now, by combining our resources, solutions, experience and customer relationships with those of CoolSys Energy Solutions, we will be able to provide our customers with an even broader set of solutions and expand our market presence." ■

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Delhi office : 312, Prakashdeep, Tolstoy Marg, Connaught Place, New Delhi 110001.Tel : 011 43629500
Chennai office : office no. 728 ,'AMARA SRI", situated at Old No.313, New No.455, Block No.75, 7th Floor,Anna Salai, Teynampet, Chennai 600018. Tel +91 44 4904 8300

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ATREA Joins Eurovent

Following a formal approval by the Eurovent Board of Directors, ATREA has officially joined the Eurovent Association. Based in the Czech Republic in the city Jablonec nad Nisou, the company is a leader in the production of ventilation and heat recovery equipment and home to a team of top-quality, trained professionals. Since its foundation in 1990, the basic principle of ATREA is to decrease the operational energy demand of air-handling equipment – mainly through the use of state-of-the-art heat recovery exchangers, built-in controls and a gradual transition to fully automatic ventilation control systems – all of which it produces itself.

ATREA's CEO Daniel Morávek states: "Through joining the Eurovent Association and its vast network of associations and manufacturers across Europe, we are underlining our ambition as a leading European manufacturer in our sector. Our central location in Europe and high level of innovation allows us to provide high-quality equipment in a short time to clients all over the continent." Morten Schmelzer, Executive Director at Eurovent adds, "We are very proud to welcome ATREA to the Eurovent family. Through the Eurovent Regional Office in Prague, our association is close to manufacturers in Central and Eastern Europe, understands local economies, and can support members in their mother tongue concerning important issues such as EU legislation and export." ■

Refcom Welcomes F Gas warnings

The UK's leading F Gas Register operator Refcom has welcomed a parliamentary report that seriously questions the UK's progress on reducing emissions of global warming gases. Head of Refcom Graeme Fox said he was delighted that the cross-party Environmental Audit Committee (EAC), which is chaired by Labour MP Mary Creagh, had taken on board all of the concerns he submitted in written evidence and during a face-to-face inquiry last year about lack of enforcement of the F Gas regulations. The EAC believes the Environment Agency is under-resourced and, therefore, incapable of enforcing the regulations effectively. It pointed to "large levels of non-compliance" and the fact that there had been just one prosecution since they came into force. In its report 'UK Progress on Reducing F Gas Emissions', the EAC called on the government to increase the resources available for monitoring usage and sales of refrigerant gases – particularly, online where Refcom

has noted a considerable rise in the availability of unregulated and potentially counterfeit supplies; some using disposable cylinders that have been illegal for more than a decade. The committee also highlighted safety concerns around flammable gases and their use by unqualified individuals."The committee picked up on our concerns around the issue of people using flammable refrigerants to top up systems not designed for their use. It acknowledged that the use of refrigerants with lower global warming potential often has a trade off in terms of safety and efficiency," said Fox. ■

Clean Seas Seafood Launches SensoryFresh

The world's largest 'full-cycle' breeder and farmer of Yellowtail Kingfish, Clean Seas Seafood Limited, has launched SensoryFresh which combines a range of rapid freeze technology and logistics protocols to deliver its Spencer Gulf Hiramasa Kingfish in a new premium frozen format. SensoryFresh uses Liquid Nitrogen Rapid Freezing technology in an effort to capture the texture, colour, aroma and taste of 'freshly harvested' fish. It delivers sensory attributes that have made Spencer Gulf Hiramasa Kingfish the choice of Sushi masters and leading chefs around the world.

"Freezing high value, premium quality seafood is all about speed," said Managing Director & CEO of Clean Seas Seafood Limited, David Head. "The ice formation stage must be achieved as fast as possible for optimum texture and Clean Seas Rapid Freezing does this in around 22 minutes, 10 times faster than conventional freezing. And to capture the colour, aroma and flavour -35C must be reached quickly. Conventional freezing won't do this. Our Rapid Freezing achieves surface temperatures of -95C and core temperatures of -50C to -70C. We call it SensoryFresh--the closest thing to ocean fresh." Japanese trained Sushi Master, Shaun Presland, Group Executive Chef at Sake Restaurants in Australia, was the first Chef to trial the SensoryFresh product, "I was seriously overwhelmed with how good this product is. The bloodline, the firm flesh and the aroma felt like this fish had just jumped out of the ocean," said Presland. Over the past 18 years Clean Seas has established a reputation for its consistent supply of high quality fresh product twice weekly, fifty-two weeks a year by air to the leading cities of the world. Clean Seas describes its Spencer Gulf Hiramasa Kingfish as Probably, the best raw fish in the world. ■

Cold Chain Market Worth USD 293.27 bn by 2023

The global cold chain market is estimated to account for USD 203.14 billion in 2018 and is projected to reach USD 293.27 billion by 2023, at a CAGR of 7.6%. The global cold chain market is expanding with considerable growth potential for over the next five years. The growth of this market can be attributed to the growth of international trade of perishable foods, technological advancements in refrigerated storage & transport, government support for the infrastructural development of the cold chain industry and increase in consumer demand for perishable foods. Also, expansion of food retail chains by multinationals will enhance international trade and impact the growth of the cold chain market.

The two main types of cold chain infrastructure are refrigerated transport and refrigerated storage. The refrigerated storage market is estimated to be dominated by the Asia Pacific region. Refrigerated storage capacities are growing in the Asia Pacific due to the increased need for reducing wastage of perishable foods. In North America and Europe, the refrigerated transport industry is booming, mainly due to the advancement of technology in refrigerated trucks, vans, trailers, and maritime reefer. Dairy & frozen desserts are estimated to account for the largest market share in the frozen cold chain market in 2018, due to their need for constant temperature control (being temperature-sensitive products), dust, and exposure to sunlight. Dairy & frozen desserts are witnessing high demand due to economic growth and rapid urbanization. ■

Ingersoll Rand Advances Climate Commitment with RE

Ingersoll Rand, a world leader in creating comfortable, sustainable and efficient environments, announced that it has achieved a significant milestone in its global climate commitment ahead of schedule and is deepening its commitment with on-site and off-site renewable energy investments.

Ingersoll Rand achieved a significant milestone in its global climate commitment ahead of schedule and is deepening its commitment with on-site and off-site renewable energy investments. As part of its global climate commitment, Ingersoll Rand committed to a 35 percent reduction of its greenhouse gas (GHG) footprint from its own operations by 2020. To deliver on this goal, the company targeted a 10 percent increase in energy efficiency from a 2013 baseline - and has achieved the goal two years ahead of schedule1.

"Energy efficiency is a primary consideration in everything we do across our own operations and for our customers in the building, industrial and transport industries," said Paul Camuti, Senior Vice President of Innovation and Chief Technology Officer for Ingersoll Rand. "We are pleased to achieve this significant milestone and thank the Ingersoll Rand team around the world for reducing energy use and our impact on the environment and enhancing sustainable value for our customers." Ingersoll Rand conducted an energy audit of its own large facilities and upgraded air conditioning systems, building controls and lighting, and eliminated energy leakage from its compressed air systems while measuring, validating and reporting the results. It reduced energy use by 109,000 MM BTUs and electricity consumption by 22,000 MWh, which is the equivalent of not burning 26 million pounds of coal and powering 1,750 homes for one year. ■

Danfoss Opens Office in Hamburg

Danfoss opened its new office in the Columbus Haus in Hamburg's HafenCity. The premises cover 1,600 square meters of office space for 120 employees, and 75 colleagues from all four company segments have already started working at the new location. The office is not just an ultra-modern workplace - it is also a hub with a focus on issues such as energy efficiency, digitalization and flexible co-working.

Jürgen Fischer, President of Danfoss Cooling (left), Jørgen M. Clausen, Chairman of Danfoss, with his wife Anette Nøhr Clausen, and Ole Møller-Jensen, President of Danfoss' Central European Region (right)

Danfoss is one of the most widely diversified full-range suppliers of components and systems for energy-efficient heating, cooling and air conditioning technology. The company supplies HafenCity, including the Elbphilharmonie Concert Hall, with intelligent, energy-saving technology for buildings and district heating systems.

"Our new office location in the heart of Hamburg could quickly become a magnet for talents and professionals from a wide range of industries," says Ole Møller-Jensen, President of Danfoss' Central European Region.

"Energy efficiency, digitalization and co-working are currently our core topics, ensuring that exciting synergies will arise at this attractive location. At the same time, we are represented throughout HafenCity with our energy-saving heating, cooling and air-conditioning technologies, providing us with important reference projects, such as the Elbphilharmonie Concert Hall, in our immediate vicinity." ■

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Tel: +91 20 2592 0000 | Fax: +91 20 2585 0080 | Email: info@testo.in

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RC AC Units Installed at Louvre

Mitsubishi Electric Hydronics & IT Cooling Systems, through its brand RC, supplied the air conditioning units to the Louvre. Formerly a royal palace, the Louvre has embraced the history of France for eight centuries. Intended as a universal museum since its inception in 1793, its collections—among the finest in the world—span several thousands of years and a territory that extends from America to the confines of Asia. With over eight million visitors in 2017, the Louvre is the world's most visited museum.

The Louvre has always remained true to its mission of promoting encounters between its art collections and visitors. More than just a meeting place, it is now clearly a forum for sharing, open and generous, accessible to everyone. Ever since the 'Grand Louvre' project, which in 1989 doubled the available exhibition area, the Louvre has constantly sought to build, restore, or redevelop its gallery spaces to provide an optimal setting for its collections. Considering the extensive art collection that the Louvre houses, the temperature and humidity is of utmost importance. Thus, when it came time to upgrade the air conditioning units, a RC solution was chosen. Going into detail, 41 chilled water high precision air conditioners, RC branded, with an over airflow configuration and air in-take from the rear for a total cooling capacity of 2,645 kW were installed. These units achieve excellent heat removal, ensuring the highest energy efficiency and reliable temperature. Thanks to an advanced algorithm, Adaptive Set Point (ADS) the units instantaneously detect the actual thermal load, and the chillers are able to adjust accordingly. ■

APM Terminals Launches Integrated Cold Chain Solutions

APM Terminals inaugurated its first state-of-the-art cold storage warehouse in India, which will ensure reliable and stable transport of cargo, including goods such as fish, fruits, medicines, and specialty chemicals, which require strict temperature control throughout the supply chain. The facilities will provide refrigerated container plug-in facilities for cold warehousing with services ranging from customs examination and clearance under controlled temperature, value-added services like palletization and packaging, on-wheel customs seal verification, and bonded cargo movement to different seaports and airports. The services are available for both domestic and international import/export customers.

Spread over 10,000 square meters, the cold chain solutions facility is the first of its kind in South India as it is integrated with APM Terminals' container freight station. The facility will offer customs clearance facilitation and proximity to the ports of Chennai, Ennore, Kattupalli and Krishnapattnam with round the clock accessibility. An additional cold chain solutions facility for domestic use has been built in close proximity to the container freight station.

Located in Ponneri, one of the fastest growing suburbs of Chennai, the facilities, which were built using the latest technologies, were inaugurated by M. Ajit Kumar, Chief Commissioner of Customs, Chennai Zone, in the presence of Dries van Dongen, Global Head of Inland Services for APM Terminals, officials from different Government offices, and key customers during a ceremony on 12th April 2018.

"We are committed to providing integrated specialty warehousing services globally. APM Terminals is constantly looking for ways that we can best address the supply chain needs of our customers. India has seen an increasing demand for temperature and humidity-controlled products especially frozen foods and pharmaceutical products for both domestic consumption as well as international export. We've invested in not only offering global standards of cold chain solutions, but also offering export-import cold chain solutions within our container freight station, for the first time in South India" said Dries van Dongen, APM Terminals' Global Head of Inland Services. ■

France Ratifies Kigali Amendment

On March 29, France became the 31st state to ratify the Kigali Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer. The aim of this amendment adopted in Kigali on October 15, 2016, is to incorporate hydro fluorocarbons – powerful greenhouse gases used mainly in refrigeration and air conditioning – into the Montreal Protocol, which entered in force on January 1, 1989.

By setting a timetable for reducing the consumption and production of HFCs, the Kigali Amendment should make it possible to prevent some 72 billion tons of CO2 equivalent of emissions by 2050 and temperature increases of nearly 0.5°C due to HFCs by 2100. It will therefore fully contribute to the implementation of the Paris Agreement. The approval of this amendment, whose requirements are already covered by our national law, including our obligations under European law, reaffirm France's ambitious and unwavering commitment to the fight against climate change and the protection of the environment. The Kigali Amendment will enter in force on January 1, 2019. ■

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To exhibit, please contact:

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Apollo LogiSolutions Appoints Samarnath Jha as CEO

Apollo LogiSolutions Limited (ALS), the leading integrated logistics solutions provider, announced the appointment of Samarnath Jha as its new Chief Executive Officer (CEO) and Director on the Board. Jha, with close to two decades of rich experience in the logistics industry, will spearhead the company's operations in India and international markets. The appointment comes into effect from April 2, 2018 and is in line with the view of the company's aggressive plans for future.


Samarnath Jha

Announcing the appointment of the senior leadership in the company, Raaja Kanwar, Chairman & Managing Director, Apollo LogiSolutions said, "As we move into the next phase of our growth journey, the appointment of Samarnath Jha as the new CEO is a step in that direction. Under the leadership of Samarnath, the group is embarking upon an exciting phase. Currently, there is huge momentum in the logistics industry and we are preparing ourselves to take full advantage of the opportunities and challenges ahead."

Samarnath Jha, CEO, Apollo LogiSolutions said, "My focus will be to build the ALS brand as the preferred choice for our customers. I look forward to working with a great team and strengthen our connections with a growing universe of customers and business partners around the world."

A fellow & life member of The Chartered Institute of Logistics & Transport, India, Jha is also on the Advisory panel of Express, Logistics & Supply chain conclave. ■

Goeller Re-elected for Third Term

At this year's Annual General Meeting of the European Partnership for Energy and the Environment (EPEE), members re-elected Juergen Goeller from UTC-Carrier for another two-year mandate as Chair. The renewed Steering Committee will continue to drive forward the work of the trade association. Within the different EPEE Working Groups, members also elected the Chairs and Vice-Chairs.


Juergen Goeller

"EPEE has enjoyed a very successful – and busy – last twelve months" explained EPEE Director General Andrea Voigt. "We welcomed three new members: GREE, Krajowe Forum Chłodnictwa, and Daikin Refrigerants. We also held events across Europe and the world on f-gas, heating & cooling, energy efficiency, and much more, and have further positioned our association as a leading voice on the European and global stage." The last year has been marked by a number of activities and fascinating projects that EPEE will further develop during the upcoming year.

EPEE is collaborating with three partner associations – AREA, ASERCOM and EFCTC – to carry out a communications campaign on f-gas, targeting installers in particular, and aiming to ensure that all stakeholders understand the importance of implementing the F-gas Regulation. To this end, the associations have developed a dedicated leaflet, translated in many EU languages that they are distributing across Europe. They also produced a video reflecting the leaflet's messages that will be shared broadly. ■

HARDI Hires Rock, Expands Talent Training Solutions Team

Heating, Air-conditioning & Refrigeration Distributors International (HARDI) has expanded its training solutions operations capacity with the hiring of Training Specialist Liz Rock. She brings a trove of experience in HR and employee training from her previous tenures as a business analyst at HealthSCOPE Benefits and as a training specialist at Progressive Medical. "HARDI members are increasingly becoming aware and taking advantage of the resources available to them under our ever-growing Talent pillar," said Manager of HR & Training Solutions Nick Benton. "Liz is the perfect fit for what our team needed to be able to sustain and improve how we serve HARDI members." HARDI Talent initiatives that Rock will be directly involved with include updating and refining the HEAT.U course library, growing HARDI's certification programs, and providing support to members on any of their Talent-related needs. Rock's addition also enables HARDI to expand custom Talent services for interested members.


Liz Rock

"I am very excited to be joining the team at HARDI," said Rock. "I look forward to helping grow our resources under the Talent pillar and expanding the access to HARDI training solutions for members. Liz not only has the specific background we were looking for in this role – she is a very bright and down-to-earth individual who fits in well with the HARDI association culture," said CEO Talbot Gee. ■

Daikin Success at H&V News Awards

Daikin's Sky Air A series range of R32 air conditioners completed a hat-trick of awards on Thursday night, being named Air Movement Product of the Year in the H&V News Awards. The event, hosted by comedian Sean Lock at London's Grosvenor House Hotel, saw Daikin beat eight other shortlisted companies to the award. The Sky Air A series, which uses the lower GWP refrigerant R32, claims energy efficiencies of up to A++ and SEER up to 7.7.

Introduced last year, the new Sky Air series subsequently won the Air Conditioning Innovation category at the Cooling Industry Awards and Energy Efficient Product of the Year HVACR at the Energy Awards 2017. ■

Chemours CEO Receives Top Industry Honor

The Chemours Company, a global chemistry company with leading market positions in titanium technologies, fluoroproducts and chemical solutions, announced its President and CEO Mark Vergnano received the 2018 American Institute of Chemical Engineers' (AIChE) Government and Industry Leaders (AGILE) Award. The award honors leaders who have made significant contributions to the chemical engineering profession and whose innovations and creativity have made a significant impact within the marketplace and global community.

"It's truly an honor to receive the AIChE AGILE Award," said Chemours President and CEO Mark Vergnano. "But it's far from an individual achievement. This award is a testament to the combined power of great people and a values-driven culture within Chemours. We're eager to continue advancing higher value chemistry and playing a meaningful role in the larger community of engineers and scientists who make the impossible possible." As the AGILE Award winner, Vergnano delivered the keynote address earlier today at the AIChE Spring Meeting and Global Congress on Process Safety in Orlando, Florida. ■

Special Awards at REHVA Annual Meeting 2018

The REHVA Professional awards 2018 took place during the REHVA Annual meeting on 21-23 of April in Brussels, Belgium. Professional awards were distributed during the Gala Dinner by the President of REHVA, Stefano Corgnati. The following members of REHVA Member Associations received a REHVA Award:

Serafin Grana (OEP-Portugal) received a REHVA professional award in design and was recognized for his outstanding achievements in the design of HVAC systems and for his contributions to improve energy efficiency and the indoor environment of buildings. Ivan Chmúrny (SSTP-Slovakia) received a REHVA professional award in education and was recognized for his outstanding academic achievements and for his contributions to improve energy efficiency and the indoor environment of buildings. Bernd Pasterkamp (VDI-Germany) and Risto Kosonen (FINVAC-Finland) received a REHVA professional award in technology and were recognized for their outstanding achievements in technology and for their contributions to improve energy efficiency and the indoor environment of buildings. Aleksandrs Zajacs (AHGWTEL/LATVAC-Latvia) and Tuomo Niemelä (FINVAC-Finland) received a REHVA Young Scientist Award and were recognized for their outstanding scientific achievements and for their contributions to improve energy efficiency of buildings.

REHVA dedicated the third day of its 2018 Annual Meeting to supporters, with a traditional Supporters Committee, a tailored technology and research committee meeting. During the Gala dinner REHVA President Stefano Corgnati handed out special supporters' awards. One of them to Uponor CEO, Jyri Luomakoski to celebrate the company's 100-years anniversary and acknowledge their longstanding collaboration with REHVA. Swegon Group Competence Director, Mikael Börjesson received two awards: one from REHVA as a tribute for being our committed supporter for more than a decade, and a second award from SCANVAC, represented by Siru Lönnqvist, who handed out a SCANVAC award for the Swegon Air Academy. ■

Clean Room Technology

A clean room is an enclosed space in which airborne particulates, contaminants, and pollutants are kept within strict limits, ordinarily utilized as a part of assembling, including of pharmaceutical items or logical research, and in addition aviation semiconductor building applications...

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Clean room technology

A clean room is an environment where air born particulates are controlled through an exchange of highly filtered air, and through minimization of activities that generate particles. A clean room is an enclosed space in which airborne particulates, contaminants, and pollutants are kept within strict limits, ordinarily utilized as a part of assembling, including of pharmaceutical items or logical research, and in addition aviation semiconductor building applications. In industry, clean rooms are used in the manufacture and servicing of hardware such as integrated circuits (IC s) and hard drive s. In biotechnology and medicine, clean rooms are used when it is necessary to ensure an environment free of bacteria,

viruses, or other pathogens. The electronic, high-tech, semiconductor, pharmaceutical, aerospace, medical and many other industries depend on clean room technology. As products such as cell phone circuit boards become smaller, the chance of contamination in manufacturing becomes higher. For pharmaceutical companies, clean, safe and contaminant-free products are imperative to manufacturing and distributing a viable product. In addition, the temperature and humidity may be controlled. Clean room specifications for particulate matter (such as dust) are defined according to the maximum allowable particle diameter, and also according to the maximum allowable number of particles per unit volume (usually cubic meters). For non-particulate contaminants, the maximum allowable density in terms of microbes per cubic meter, or molecule s per cubic meter, is specified. Four fundamental rules apply to clean rooms. First, contaminants must not be introduced into the controlled environment from the outside. Second, the apparatus within the controlled environment must not generate or otherwise give rise to contaminants (for example as a result of friction, chemical reactions, or biological processes). Third, contaminants must not be allowed to accumulate in the controlled environment. Fourth, existing contaminants must be eliminated to the greatest extent possible, and as rapidly as possible.

Managing a Clean Room

Personnel selected to work in clean rooms undergo extensive training in contamination control theory. They enter and exit the clean room through airlocks, air showers and/or gowning rooms, and they must wear special clothing designed to trap contaminants that are naturally generated by skin and the body. Depending on the room classification or function, personnel gowning may be as limited as lab coats and hairnets, or as extensive as fully enveloped in multiple layered bunny suits with self contained breathing apparatus. Clean room clothing is used to prevent substances from being released off the wearer's body and contaminating the environment. The clean room clothing itself must not release particles or fibers to prevent contamination of the environment by personnel. This type of personnel contamination can degrade product performance in the semiconductor and pharmaceutical industries and it can cause cross-infection between medical staff and patients in the healthcare industry for example. Clean room garments include boots, shoes, aprons, beard covers, bouffant caps, coveralls, face masks, frocks/lab coats, gowns, glove and finger cots, hairnets, hoods, sleeves and shoe covers. The type of clean room garments used should reflect the clean room and product specifications. Low-level clean rooms may only require special shoes having completely smooth soles that do not track in dust or dirt. However, shoe bottoms must not create slipping hazards since safety always takes precedence. A clean room suit is usually required for entering a clean room. Class 10,000 clean rooms may use simple smocks, head covers, and booties. For Class 10 clean rooms, careful gown wearing procedures with a zipped cover all, boots, gloves and complete respirator enclosure are required.

Air Flow Principles

Clean rooms maintain particulate-free air through the use of filters employing laminar or turbulent air flow principles. Laminar, or unidirectional, air flow systems direct filtered air downward in a constant stream. Laminar air flow systems are typically employed across 100% of the ceiling to maintain constant, unidirectional flow. Laminar flow criteria is generally stated in portable work stations, and is mandated in ISO-1 through ISO-4 classified clean rooms. Proper clean room design encompasses the entire air distribution system, including provisions for adequate, downstream air returns. In vertical flow rooms, this means the use of low wall air returns around the perimeter of the zone. In horizontal flow applications, it requires the use of air returns at the downstream boundary of the process. The use of ceiling mounted air returns is contradictory to proper clean room system design.

Positive Pressure

Clean rooms are designed to maintain positive pressure, preventing "unclean" (contaminated) air from flowing inside and less-clean air from flowing into clean areas. The idea is to ensure that filtered air always flows from cleanest to less-clean spaces. In a multi-chambered clean room, for instance, the cleanest room is kept at the highest pressure. Pressure levels are set so that the cleanest air flows into spaces with less-clean air. Thus, multiple pressure levels may need to be maintained. A differential air pressure of 0.03 to 0.05 inches water gauge is recommended between spaces. In order to minimize disruptions to these cascading pressures when doors are opened, air locks are often specified between rooms of differing ISO cleanliness levels. Automated fan controls simplify pressure balancing by allowing fan speed adjustments at a centralized console panel.

Clean Room Standardization

In the United States, Federal Standard 209E (FED-STD-209E) was used until the end of November 2001 to define the requirements for clean rooms. On November 29, 2001, these standards were superseded by the publication of ISO specification 14644-1. Typically, used in manufacturing or scientific research, a clean room is a controlled environment that has a low level of pollutants such as dust, airborne microbes, aerosol particles, and chemical vapors. To be exact, a clean room has a controlled level of contamination that is specified by the number of particles per cubic meter at a specified particle size. The ambient air outside in a typical city environment contains 35,000,000 particles per cubic meter, 0.5 micron and larger in diameter, corresponding to an ISO 9 clean room which is at the lowest level of clean room standards. Clean rooms are classified by how clean the air is. In Federal Standard 209 (A to D) of the USA, the number of particles equal to and greater than 0.5mm is measured in one cubic foot of air, and this count is used to classify the clean room. This metric

Table 1: Some of the real-world applications of clean rooms:

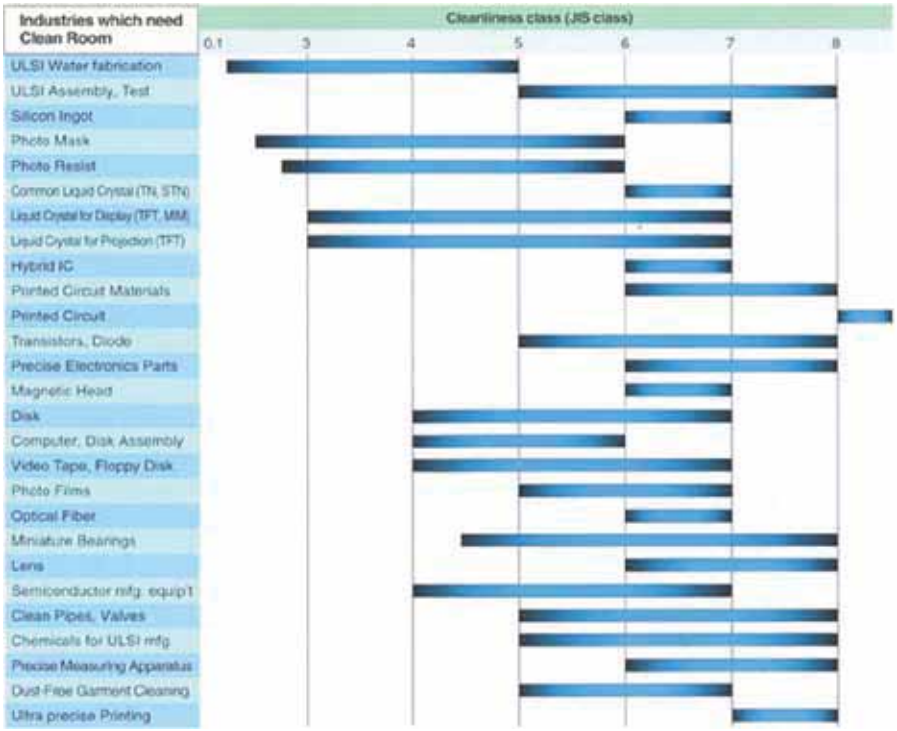
Common Applications	Special Applications
• E-Liquid and E-Cigarette Manufacturing Rooms • Cannabis Cultivation Rooms • IV Rooms • USP 797 Compounding Labs • USP 800 Clean Rooms • GMP Rooms • Laboratories • Gown Rooms • CMM Rooms • Pharmaceutical Packaging • Printing Rooms	• Animal Housing Labs & Vivariums • Controlled & Critical Environments • Powder Coating Enclosures • Packaging Rooms • Machine Enclosures • Environmental Enclosures • Metrology Labs • Microelectronics Manufacturing • Nano Technology • Paint System Enclosures • Fab Labs • Storage Rooms

nomenclature is also accepted in the most recent 209E version of the Standard. Federal Standard 209E is used domestically. The newer standard is TC 209 from the International Standards Organization. Both standards classify a clean room by the number of particles found in the laboratory's air. The clean room classification standards FS 209E and ISO 14644-1 require specific particle count measurements and calculations to classify the cleanliness level of a cleanroom or clean area. In the UK, British Standard 5295 is used to classify cleanrooms. This standard is about to be superseded by BS EN ISO 14644-1. Cleanrooms are classified according to the number and size of particles permitted per volume of air. Large numbers like 'class 100' or 'class 1000' refer to FED_STD-209E and denote the number of particles of size 0.5 mm or larger permitted per cubic foot of air. The standard also allows interpolation, so it is possible to describe e.g. 'class 2000.'

Small numbers refer to ISO 14644-1 standards, which specify the decimal logarithm of the number of particles 0.1 μm or larger permitted per cubic metre of air. So, for example, an ISO class 5 clean room has at most 105 = 100,000 particles per m^3. Both FS 209E and ISO 14644-1 assume log-log relationships between particle size and particle concentration. For that reason, there is no such thing as zero particle concentration. Ordinary room air is approximately class 1,000,000 or ISO 9. The table illustrates the percentage of ceiling coverage recommended for each cleanliness class, again as a range:

Class	Ceiling Coverage (Percentage)
ISO 8 (Class 100,000)	5 – 15%
ISO 7 (Class 10,000)	15 – 20%
ISO 6 (Class 1,000)	25 – 40%
ISO 5 (Class 100)	35 – 70 %
ISO 4 (Class 10)	50 – 90%
ISO 3 (Class 1)	60 – 100%
ISO 1-2	80 – 100%

Figure 1: Some of the industries which need clean room and the cleanliness



Clean Room Applications

Clean rooms are used in practically every industry where small particles can adversely affect the manufacturing process. They vary in size and complexity, and are used extensively in industries such as semiconductor manufacturing, pharmaceuticals, biotech, medical device and life sciences, as well as critical process manufacturing common in aerospace, optics, military and Department of Energy. A clean room is any given contained space where provisions are made to reduce particulate contamination and control other environmental parameters such as temperature, humidity and pressure. Filters are used to trap particles that are 0.3 micron and larger in size. All of the air delivered to a clean room passes through standard filters, and in some cases where stringent cleanliness performance is necessary, Ultra Low Particulate Air (ULPA) filters are used. Clean room systems can be used in a wide variety of applications. Clean room applications range from small laboratories to gigantic clean rooms in the automotive or aerospace industry. The requirement for contamination or environmentally controlled manufacturing is becoming more and more prevalent across a variety of industries and markets: alternative energy, e-cigarettes, ion lithium batteries,

solar and more. Some of these emerging clean room applications are to support technology and process advancements in traditionally non-clean process applications. Others are in response to changes in regulatory requirements. And yet others are to support breakthrough disruptive technologies and new markets. The table 1 gives a view for some of the real-world applications of clean rooms.

The figure 1 shows some of the industries which need clean room and the cleanliness class generally applied therein:

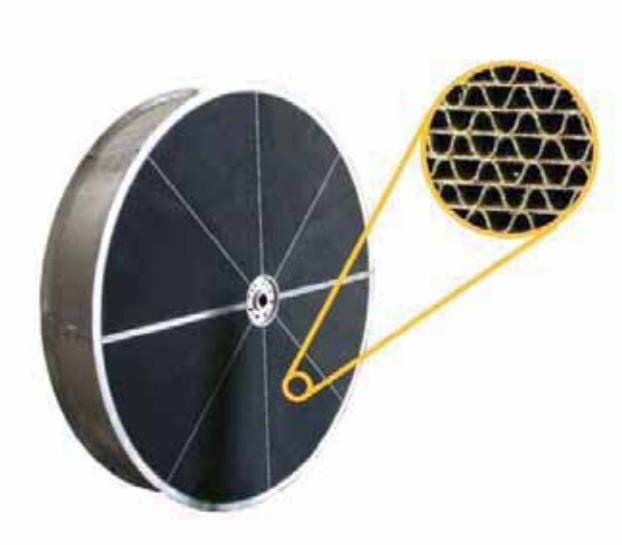
Clean Room Guidelines

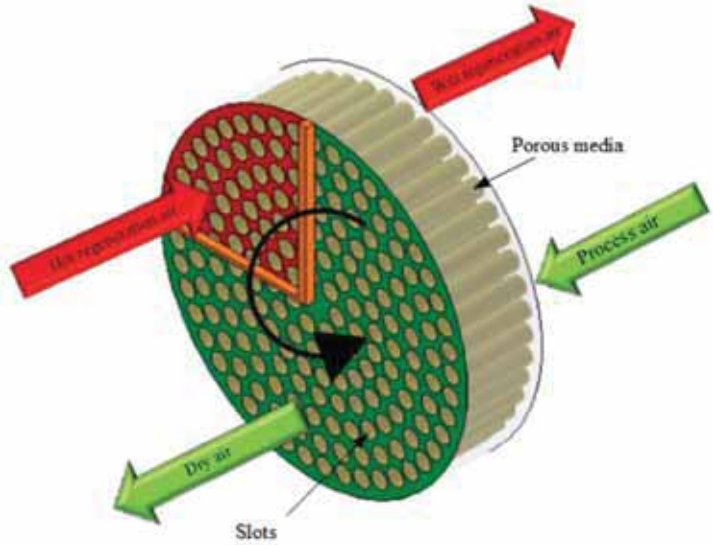
- Protect the clean room environment against human contamination
- Not to generate contamination
- Protect people against solid or liquid hazardous substances and biological hazards
- Allow heat exchange, and air and moisture vapour permeability for the wearer's comfort
- Provide consistently high two-way protective performance, by virtue of being limited-use.
- People are the most serious source of particle emission in a clean room. Regular clothing can expose products or processes to material particle shedding, residues and foreign particles. Effective particle barrier clothing functions as a personal filter that protects clean rooms from contamination by people.
- At the same time, some clean room work requires the protection of people from hazardous substances, such as liquid or solid chemicals or biological agents. These hazards occur not only in chemical, pharmaceutical and microbiological environments, but even in the production of computer chips or when painting under clean room conditions. Traditional clean room clothing simply does not provide adequate personal protection.
- Both clean room clothing and chemical protective clothing need to meet the same basic criteria for use in a clean room: The material must be low-linting, the design must be sufficiently tight, and the danger of collecting particles on the surface of the garment must be minimized. ■

Dr S S Verma
Department of Physics,
S.L.I.E.T.,
Longowal

Desiccant Based Rotary Dehumidifiers

The purpose of this article is to study the utility of desiccant based rotary air handlers that can ameliorates the comfort, cost and energy savings in the field of space conditioning...





Desiccant based rotary dehumidifiers are found most effective in humidity control of moist air, as air handler they are also advantageous in being free from CFCs, may be using low grade industrial waste heat or freely available renewable solar energy while controlling the ambient humidity. Compared with conventional vapor compression air conditioning system, it preserves the merits of environment-friendly, energy saving, healthy, comfortable, etc. Ongoing research and development works show that new desiccant materials and novel system configurations have significant potential for improving the performance and reliability and reducing the cost and size of rotary desiccant dehumidification and air handling system, thereby, increasing its market competitiveness and breaking out the current fairly small niche market. The purpose of providing this overview is to study the utility of desiccant based rotary air handlers that can ameliorates the comfort, cost and energy savings in the field of space conditioning.

Desiccant materials attract moisture based on differences in vapor pressure between desiccant substrate and moist air. Due to their enormous affinity to adsorb water and considerable ability to hold water, desiccants have been widely applied to marine cargo, pharmaceutical, electronics, plastics, food, storage, etc. Recently, the rapid development of desiccant dehumidification and space cooling technology, which can handle sensible and latent heat loads independently without using CFCs and without consuming a large amount of electric power, and thus, meet the current demands of occupant comfort, energy saving and environmental protection, has expanded desiccant industry to a broader niche applications, such as hospitals, supermarkets, indoor swimming pools, restaurants, theaters, schools and office buildings. Since desiccants remove moisture in the vapor phase without liquid condensate, desiccant dehumidification can continue even when the dew point of the air is blew freezing; in contrast, cooling-based dehumidification is limited by freezing phenomenon occurring at 0-8°C. As a result, desiccant assisted dehumidification is capable of handling the dew point of the air to 40°C. As desiccants can be either solid or liquid, desiccant air conditioning systems can be classified into two categories, namely, solid desiccant air conditioning systems,

which consist of fixed bed type and rotary wheel type, and liquid desiccant air conditioning systems. Due to being advantageous in handling latent heat load, all these technologies have been used widely. Especially, rotary desiccant air conditioning systems, which are compact and less subject to corrosion and can work continuously, attract more attention. Desiccant materials have been playing a crucial role in the development of desiccant assisted air handling especially, during dehumidification of moist air. The characteristics of the desiccant material being utilized impact the performance of the desiccant assisted dehumidification systems significantly. Commonly used desiccant materials include activated carbon, activated alumina, molecular sieve, silica gel, lithium chloride, calcium chloride and etc. Two key principles for selecting appropriate desiccant materials are: the desiccant materials should possess large saturated adsorption amount and can be reactivated easily.

The desiccant wheel is a rotor, filled with a desiccant material (i.e. silica gel), in which humid air is dehumidified by the desiccant material, to balance latent loads of the ambient. To guarantee continuous operation, the wheel has to be regenerated by a hot air stream. The waste heat of a small cogeneration plant can be effectively used to regenerate the desiccant material, while the cogenerated electricity can drive a chiller to meet the room sensible load. The main advantages of this technology, with respect to conventional vapor compression based systems based on cooling dehumidification, are:

- The sensible and latent loads can be separately controlled;
- Very low dew point temperatures of process air, lower than -6°C, can be achieved;
- The cooling can be achieved with a higher chilled water temperature, which ultimately results in a higher COP of system;
- Due to the higher value of the COP, electric energy requirement for producing the cooling is lowered;
- As the sensible cooling coil has to handle only the sensible load of the process air, a reduction of its size is obtained; this consequently determines a lower environmental impact, both in terms of direct impact (ozone layer reduction and greenhouse effect due to refrigerant fluids) and indirect one (the reduced electric energy use determines lower equivalent CO2 emissions of the power plants);
- Consistent energy savings can be obtained to the increase in the overall energy efficiency;
- A better indoor air quality (IAQ) can be obtained, due to sanitizing effects of desiccants. Indeed, desiccant systems avoid the formation of condensed water; this strongly reduces the presence of microorganisms as bacteria, viruses and fungi.

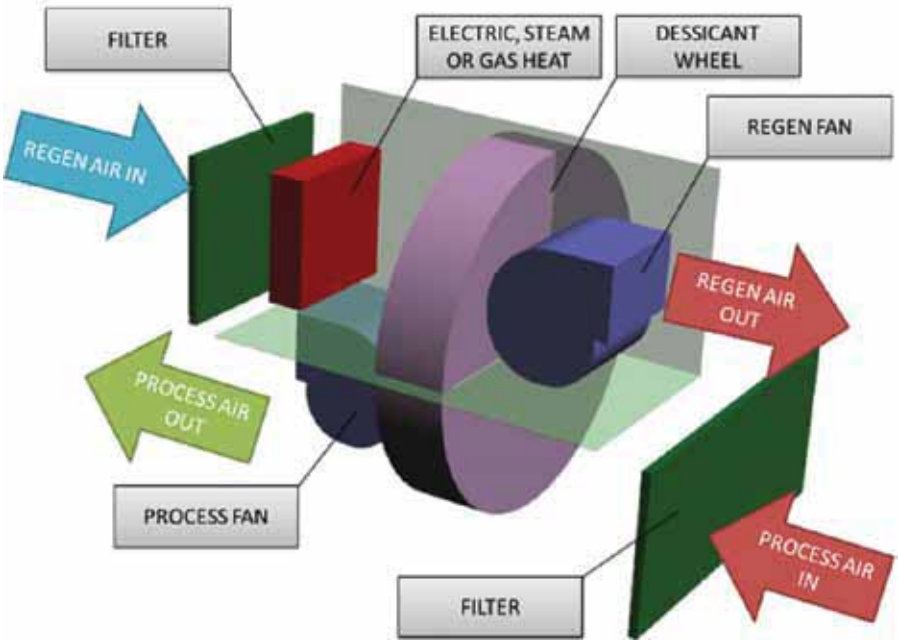


Figure 1: Working of Desiccant assisted Air Handling System for Dehumidification

Desiccant systems are especially, useful when the latent load is high (i.e., when the latent-to-sensible heat ratio is high), because they remove moisture more economically than they remove sensible heat. Another desirable situation is when the cost of dehumidification with a desiccant is lower than the cost of dehumidification with a traditional vapor compression-based refrigeration system. This is where thermal energy comes into the picture: there are instances where desiccant regeneration done by waste heat, natural gas, or off-peak electricity is more economical compared to regular electric refrigeration. Because there is no need for reheating with desiccant dehumidification systems, another appropriate use is when conditioned air must be reheated after coming out of a coil to reach a comfortable dry-bulb temperature. Finally, the use of a desiccant is well-suited to the case where dehumidification is required at levels below freezing dew-point temperatures.

Working of Desiccant Assisted Air Handling System for Effective Moisture Control

For industrial applications, solid desiccant dehumidification cycles use dual-column packed-bed dehumidifiers; however, the most appropriate dehumidifier configuration for air dehumidification applications is the rotary wheel (Fig. 1). The most desiccant dehumidifiers use the desiccant material in a rotor form. Rotors are manufactured from alternate layers of flat and corrugated sheets impregnated with the active component (desiccant). This forms a vast number of axial air channels running parallel through the rotor structure. As air passes through these channels, moisture is transferred between the air and the desiccant. The air to be dehumidified enters the system, comes

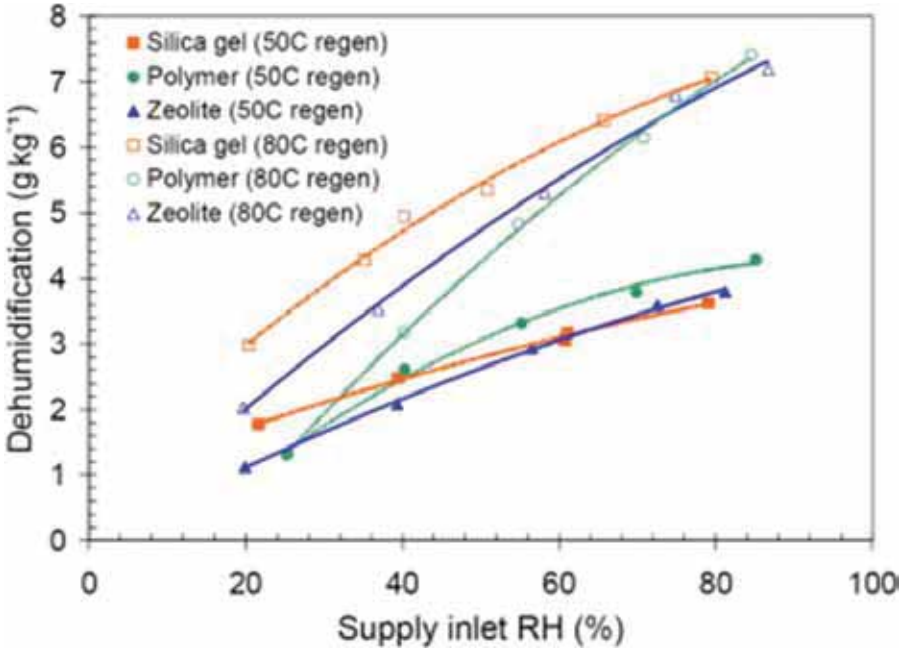


Figure 2: Effect of regeneration temperature on desorption capacity of different desiccant materials.

into contact with the desiccant wheel, and exits the dehumidifier hot and dry. The wheel is then rotated so that the desiccant portion that has picked up moisture is exposed to hot reactivation air and its moisture removed. Since the air leaving the desiccant is heated because of the release of heat adsorption, there is a need for cooling the dried air in cooling applications. This can be accomplished with a sensible heat exchanger such as a heat pipe or with a standard vapor-compression cooling coil. To re-use the desiccant, it must be regenerated or reactivated through a process in which moisture is driven off by heat from an energy source such as electricity, waste heat, natural gas, or solar energy.

Generally, our desiccant dehumidifiers comprise of five major components:

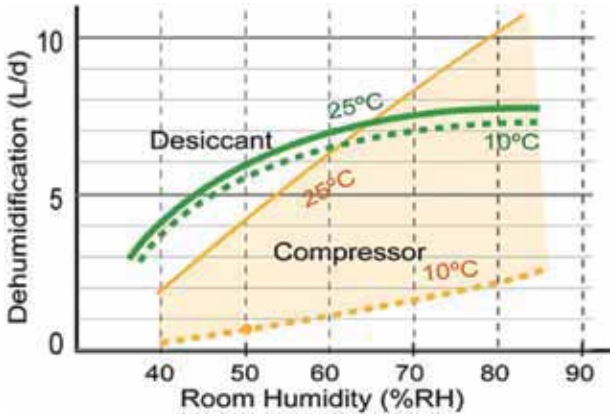
- The component that contains the desiccant material (rotor), of which there are several types.
- A fan to move the air to be dehumidified (process air) through the desiccant rotor or material.
- A fan to move hot air (reactivation air) through the desiccant rotor or material.
- A heater to heat the air that is used to regenerate the desiccant material.
- A mechanical device to slowly rotate the desiccant rotor or material bed.

Desiccant units are typically used in areas where dry conditions are essential - such as pharmaceutical and petrochemical applications - due to their ability to produce extremely low levels of humidity. The desiccant types are also purposefully selected for drying out areas where access is restricted, such as storage tanks and marine environments. Figure 2 shows the water vapor adsorption isotherms of several desiccant materials mentioned above. It is obvious that silica gel as desiccants improve adsorption capacity significantly.

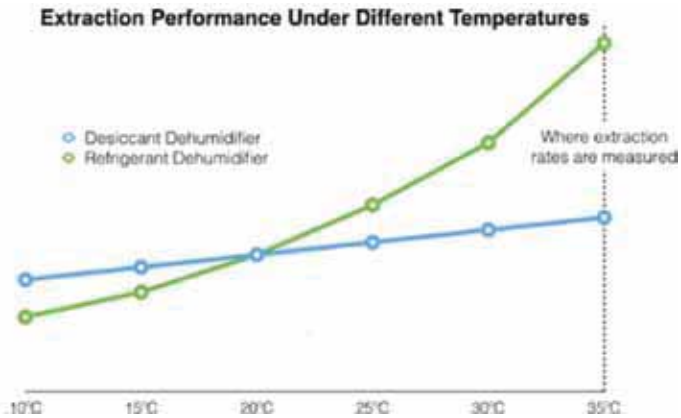
Due to the effect of adsorption heat released during the dehumidification process, the temperature of the process air is increased and its relative humidity is decreased. As a result, the vapor difference, which is actually the driving force for dehumidification, is reduced, and corresponding dehumidification ability is limited then. Because of this, much higher regeneration temperature is required to obtain desired dehumidification capacity, especially for high humid climates.

Comparison of Moist Air Handling by Desiccant Wheel and Conventional VCR System

Air dehumidification can be achieved usually by two methods: (1) cooling the air below its dew point and removing moisture by condensation or (2) sorption by a desiccant material. Conventionally, used VCR compressor dehumidifiers are the most popular systems. They create a cold surface, and once the warm and damp air inside the room hits the cold surface, condensation starts, then the water separates from the air. A desiccant



(a)



(b)

Figure 3: Performance comparison between a VCR compressor and desiccant dehumidifier.

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dehumidifier has no compressor and does not use a cold surface to extract the excess moisture from the air. Instead, it has a desiccant wheel that absorbs the moisture from the air, in a similar way to a sponge. The desiccant is regenerated by an internal heater so that the process can be repeated time and time again. Any application whereby the room air temperature is likely to fall below 15°C then you should be looking at a desiccant dehumidifier. This is because the inside of the vapor compressor dehumidifier needs to be colder than the air within the room and the colder the room is the harder the dehumidifier has to work to create that cold surface. As the temperature starts to fall down towards 10°C then the chances are that the inside of the dehumidifier will get close to freezing, increasing the changes of ice forming on the dehumidifiers cooling coils. This is why below around 15°C the vapor compressor dehumidifiers are programmed to spend up to two thirds of their time defrosting themselves rather than dehumidifying. The desiccant dehumidifiers on the other hand have a consistent performance regardless of the temperature. Both types of dehumidifier will warm the air up slightly, that is not to say that they are heaters just that they warm the air up as it passes through the dehumidifier. The air coming out of the compressor dehumidifier will be about 2°C warmer while the air coming out of a desiccant dehumidifier will be about 10-12°C warmer, quite a difference between the two (Fig. 3 (a) and (b)). So, if you are putting the dehumidifier into a hallway that is on the chilly side then the desiccant makes sense as it will warm it up, but if the hallway is already nice and toasty then the compressor dehumidifier is the correct option.

In low fan speed desiccant dehumidifiers are all just below 40db and you will not get a vapor compressor dehumidifier below 40dB. The important point is that at least with desiccant dehumidifier you have the option to switch to a quieter mode which you cannot do with a compressor dehumidifier. Compressor dehumidifiers work at temperatures between 5°C-35°C with the optimum operating temperature being 15°C. Compressor models do not work at 0°C-5°C because the cold coils cannot extract moisture from the air at these temperatures. Desiccant dehumidifiers work in temperatures from 0°C-35°C and they feature a stable humidity intake no matter what temperature so, despite at running 600w/h, a desiccant dehumidifier is cheaper to run than a comparable compressor dehumidifier. Another important note is that compressor dehumidifiers use major greenhouse gases whilst desiccant dehumidifiers do not. Therefore, desiccant dehumidifiers are eco-friendly whilst compressor dehumidifiers are not. The comparison between working of the two dehumidifiers is shown in Fig. 4. Moreover, desiccant units use no consumables, so the desiccant material will not expire, or have to be topped up or replaced.

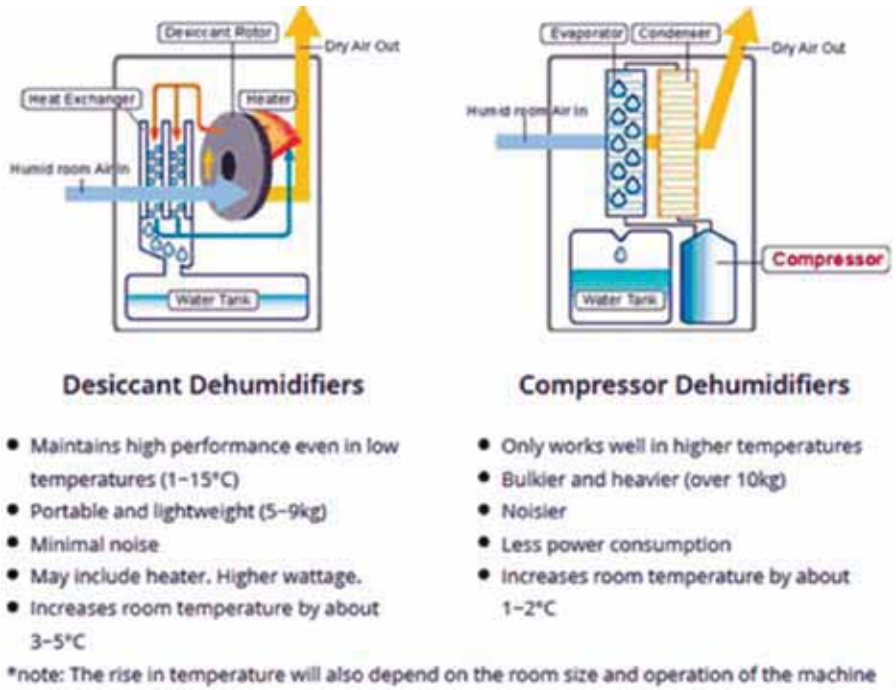


Figure 4: Working difference between a vapor compressor and desiccant dehumidifier.

Desiccant dehumidifiers range in size and configuration dramatically. Desiccants used in restorative drying can be as small as a roll-on suitcase or as large as two semi tractor-trailers. Large desiccants are often self-contained dehumidification systems, utilizing onboard generators and running on propane or diesel fuel. When large catastrophic events occur, such as hurricanes, large desiccants can provide a means of dehumidification when little or no power is available.

Conclusions

Desiccant assisted dehumidification is an established technology that has been used successfully for many years in institutional and industrial applications. Commercial applications are now gaining acceptance. Desiccant based air handling systems have been applied successfully in supermarkets and ice rinks. Hotels and motels, office buildings, and restaurants provide the next opportunity. Lowering the cost of desiccant dehumidification systems and improving their performance will clearly provide more opportunities for desiccant dehumidification technology. Currently, a number of cost-effective applications in the market will result in increased sales during the next several years; but as in other technologies, further R&D and demonstration programs will enhance broader applications of the technology. Low temperature desiccants can effectively use waste heat from electric air conditioners and improve their efficiency and effectiveness-an area that need to participate for further development.

Desiccant dehumidification systems as add-on modules to electrical refrigeration systems could help solve the challenges facing the HVAC industry especially as increased ventilation rates, need for improved indoor air quality and better humidity controls, phase-out of CFCs, national standards requiring higher efficiency for cooling systems, and desire for lowered peak electric demands. These factors, and the ability for desiccant assisted air handling systems to solve specific problems, are driving these desiccant technologies to the mainstream of the air-conditioning market. ■

Dr. (Prof.) D. B. Jani
Associate Professor Gujarat Technological University, GTU, Ahmedabad
(Education Department, State of Gujarat, India)

Prof. Kiran Bhabhor
Assistant Professor, Gujarat Technological University, GTU, Ahmedabad

Prof. Mohsin Dadi
Head of the Department (Mechanical Engineering) at Parul University, Baroda.

Ways to Optimize Refrigeration Efficiency & Lower Energy Costs

60 percent of a manufacturing facility's total operating expenses comes from industrial refrigeration. It's no surprise that refrigeration efficiency is a priority. However, engineers often look to optimize individual components rather than taking a holistic approach, leading to wasted energy and operational inefficiencies. To avoid this fragmented approach, here are six steps to optimize the entire system and achieve the greatest energy efficiency:

1. Optimize Settings

Condensing pressure should typically be run as low as possible. Suction pressure should also be run as low as possible while still maintaining the desired room or product temperatures. Even adjusting the suction pressure up a degree could mean a 1.5 percent savings for those compressors. There are many different settings and parts that can be checked to ensure optimal performance.

2. Size compressors to match loads as closely as possible

Selecting appropriately sized compressors up front can make or break your efficiency. Two equally sized compressors, each running at 50 percent capacity, can require 30 percent more horsepower than one compressor running at 100 percent.

It's also a good practice to include different-sized compressors, and to sequence them properly to keep machines as fully loaded as possible. For large systems, large compressors handle the majority of the load, while a smaller unit can be included as a trim compressor to handle the swings. This will keep the larger compressor fully loaded at all times. An analysis can help detect problems and find solutions to help compressors perform at their peak.

3. Install VFDs on screw compressors

Applying variable-frequency drives (VFDs) on screw compressors will optimize mechanical efficiencies of the machines. The best approach is to set the slide valve position at 100 percent and vary the RPM of the motor according to the refrigeration needs of the machine, which allows it to run more efficiently.

4. Install VFDs on condenser motors

Using VFDs on condenser motors can stabilize head pressure and prevent the motors from heavy repeats and intense start/stop cycles. Then, the fans can change speeds so they don't continually stop and start, which requires additional energy and results in mechanical wear. The biggest payback from a VFD will be on systems with variable load.

5. Use floating head pressure to maintain ideal temperatures

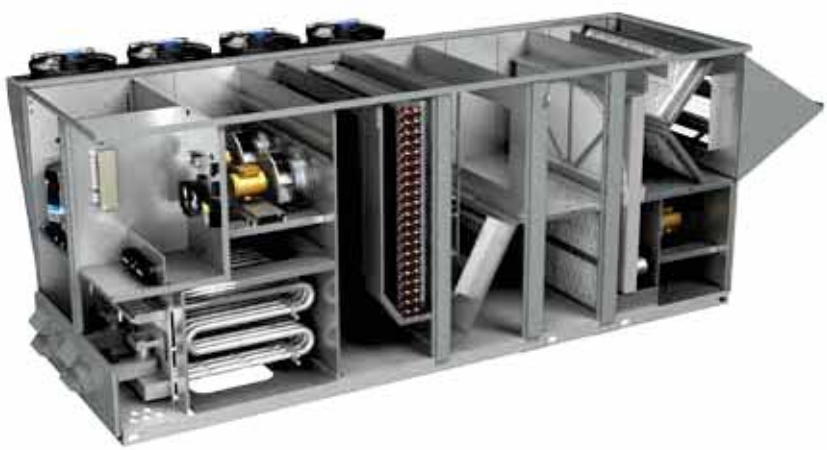
Floating head pressure can be used to maintain the ideal temperature for compressor and condenser operations. Higher condensing temperatures require compressors to work harder. Find the optimal break-even point where the condensers and compressors are cumulatively using the lowest overall horsepower requirements.

6. Use a completely integrated automation system

Running your machine with a completely integrated automation system will ensure efficiency and automate temperature controls within zones. Automating defrost cycles to sequence at different times can result in significant energy savings. An automated system can make calculations and adjustments automatically, whereas a manual system requires constant operator attention, is susceptible to human error and will react more slowly. ■

Air Handling Units Market worth USD 12.91 bn by 2026

The increase in demand of air handling units from the application sectors such as commercial buildings, industries, hospitals, universities, data centers, laboratories, and server rooms is propelling the growth of this market.



According to MarketsandMarkets report, air handling units market is projected to reach USD 12.91 billion by 2026, at a CAGR of 5.7% from 2016 to 2026. The increase in demand of air handling units from the application sectors such as commercial buildings, industries, hospitals, universities, data centers, laboratories, and server rooms is propelling the growth of this market.

Custom air handling units is the fastest-growing type segment of the global air handling units market:

The custom air handling units segment is estimated to account for the second-largest share of the air handling units market in 2016 and is projected to be the fastest-growing type segment from 2016 to 2026. The growth is mainly attributed to the rising demand of custom air handling units from the commercial application sectors such as pharmaceutical industries, shopping malls, hospitals, and universities.

15001 - 30000 m3/h capacity segment is anticipated to grow at the highest CAGR from 2016 to 2026: The 15001 - 30000 m3/h capacity segment is anticipated to grow at the highest CAGR in the air handling units market from 2016 to 2026. These are medium size air handling units which are used in commercial applications such as hospitals, shopping malls, commercial buildings, data centers, and laboratories. Due to the increasing awareness regarding the impacts of pollution on environment and human health, there is a high rise in the use of air handling units. Air handling units are not only used for cooling and heating purpose, but also for providing fresh air, humidification, and controlling relative humidity. These features contribute towards the growing demand of 15001 - 30000 m3/h capacity air handling units.

Commercial is the fastest-growing application segment of the global air handling units market: The commercial segment is estimated to account for the largest share of the air handling units market in 2016 and is projected to be the fastest-growing segment from 2016 to 2026. This growth can be attributed to the increased demand of air handling units in the commercial application sectors such as shopping malls, hospitals, universities, data centers, industries, cleanrooms, and server rooms.

Asia-Pacific estimated to be the largest market for air handling units in 2016: Asia-Pacific is estimated to be the largest market for air handling units in 2016. This large share can be attributed to the growing demand for air handling units from the application sectors such as shopping malls, hospitals, universities, data centers, industries, cleanrooms, and server rooms in this region.

Key players operational in the market include Daikin Industries, Ltd. (Japan), Carrier Corporation (US), Trane Inc. (Ireland), Johnson Controls, Inc. (US), GEA Group AG (Germany), Systemair AB (Sweden), Flakt Woods Group (Sweden), CIAT Group (France), Trox GmbH (Germany), and Lennox International Inc (US), among others. ■

Star Ratings in ACs

Keeping the performance of air conditioners during higher temperature in mind, ISEER will address the different climatic zones in India and higher temperature. ISEER measures energy efficiency of air conditioners based on a weighted average of the performance at outside temperatures between 24 and 43 degree C based on Indian weather data...

Since early 2016, the Bureau of Energy Efficiency (BEE) has introduced a new star rating methodology called Indian Seasonal Energy Efficiency Ratio (ISEER) for air conditioners. This evolved rating methodology factors in variance in higher temperature in India and rates air conditioners accordingly.

Keeping the performance of air conditioners during higher temperature in mind, ISEER will address the different climatic zones in India and higher temperature. ISEER measures energy efficiency of air conditioners based on a weighted average of the performance at outside temperatures between 24 and 43 degree C based on Indian weather data.

Since the introduction of Star Labelling for ACs in India, BEE continuously tightens the standards such that, the Star 5 in 2010 became Star 3 in 2015 and will become Star 1 in 2018 as per new ISEER methodology. The weighted average Energy Efficiency Ratio (EER) of AC has increased from 2.6 in 2006 to 3.26 in 2015, which is an increase of 25% in efficiency due to tightening of standards.

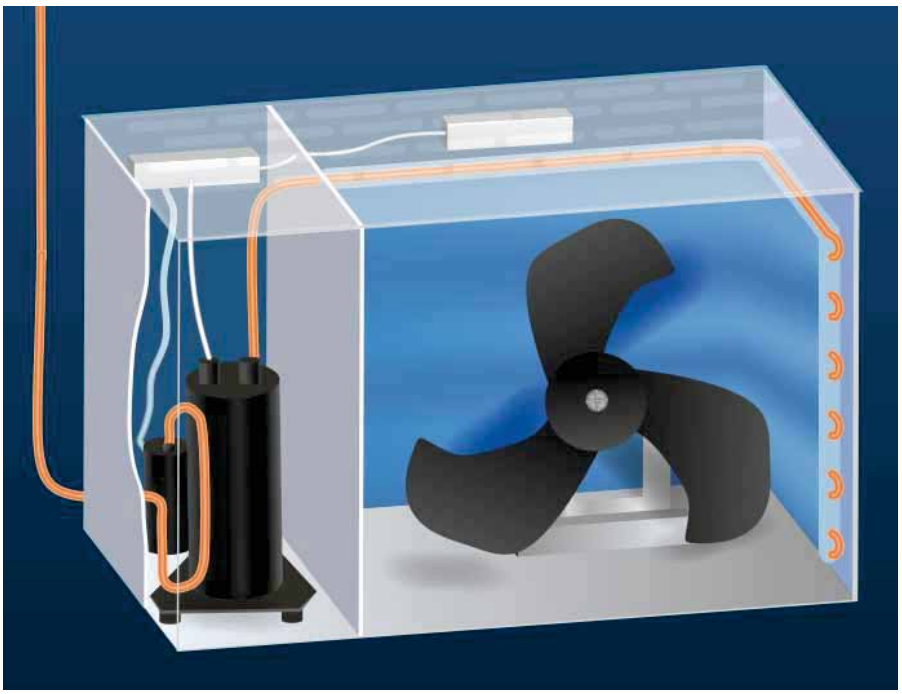
Since 2010, Bureau of Energy Efficiency has mandated air conditioners as a mandatory-labelled appliance under Energy Conservation Act and since then air conditioners cannot be sold without star label. Now as per latest notification, from January 2016, Star 2 is the least efficiency level to be sold in the market,

hence variation in power consumption is compared between Star 5 (most efficient) and Star 2 (least efficient) air conditioners.

Air conditioning already accounts for 40-60% of summer peak load in large Indian cities such as Delhi and is on track to contribute 140 gigawatts (GW) (~30%) to peak demand in 2030. India's standards and labeling policies improved the market average efficiency of room ACs by about 35% between 2006 and 2016 (3% per year) even as inflation-adjusted room AC prices continued to decline.

As per a report by Lawrence Berkeley National Laboratory, if, starting in 2018, the market average room AC efficiency improves by 6% per year instead of the current 3% per year, about 39 GW of peak load (equivalent to about 80 power plants of 500 MW each), and more than 64 TWh per year of energy (equivalent to the current electricity consumption of the entire state of Gujarat) could be saved by 2030.

It is essential to understand that the purchase of an AC Unit has to be made considering the overall lifetime cost rather than merely the initial cost of the AC Unit, which includes cost of operations, maintenance, repair and cost of replacement. Keeping in mind the efficiency and durability of the AC, International Copper Association of India (ICA India) started a campaign on 100% Copper ACs' to arm the consumers with key points to bear in mind to make a wise and informed decision.

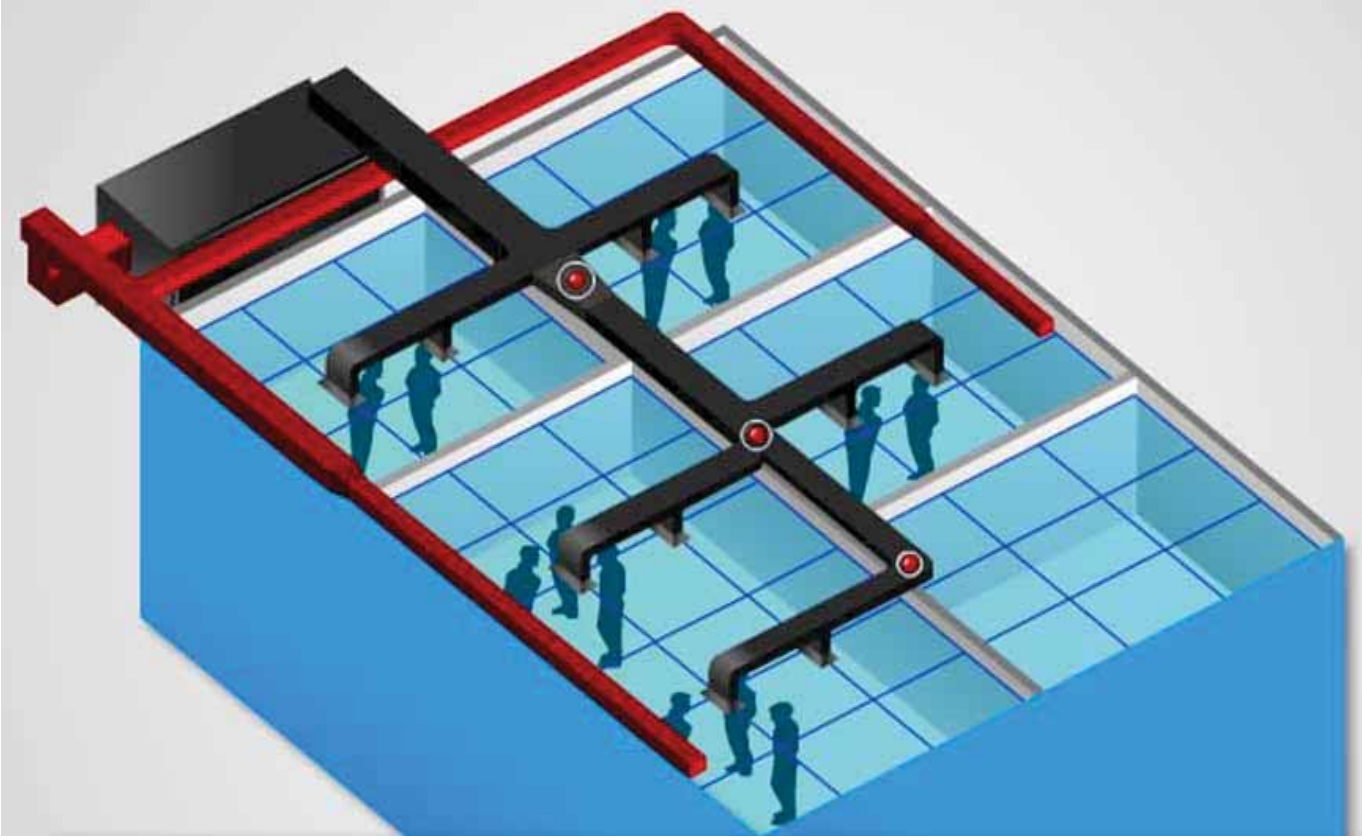


Make a smart investment this summer by choosing an air conditioner that meets your requirements. Also, maintaining and operating an air conditioner correctly can help you save a lot of electricity and reduce your electricity bills. So do make sure that you get your AC in right condition before the summer starts. ■

Avinash Khemka
Chief Manager – HVAC,
International Copper
Association India

Air Distribution System

Air distribution is the key for a successful working of air conditioning equipment. Successful working of air conditioning equipment needs efficient duct design. Duct design expenses are nearly 35 to 40% of project cost and it is required to minimise...



The conditioned air coming from air conditioning equipment must be properly distributed in the utilized area. Conditioned air cannot be directly supplied from air conditioning equipment but it is allowed to flow with the help of diffuser. The return air from room is also supplied from ducts sometimes return air is exhausted to the atmosphere. Successful working of air conditioning equipment needs efficient duct design. Duct design expenses are nearly 35 to 40% of project cost and it is required to minimise.

Factors Affecting Air Conditioning

The main objective of an air distribution system is to produce a proper combination of temperature, humidity air motion in the condition room area. The comfort condition should be maintained perfectly. Temperature fluctuation or improper air motion create discomforts.

Air needs to be properly distributed within utilized area. The velocity of air should be between 10 to 15 m/min. The flow direction of air should be towards the faces of the people. Downward flow is preferred over upward flow. The temperature of conditioned air should not

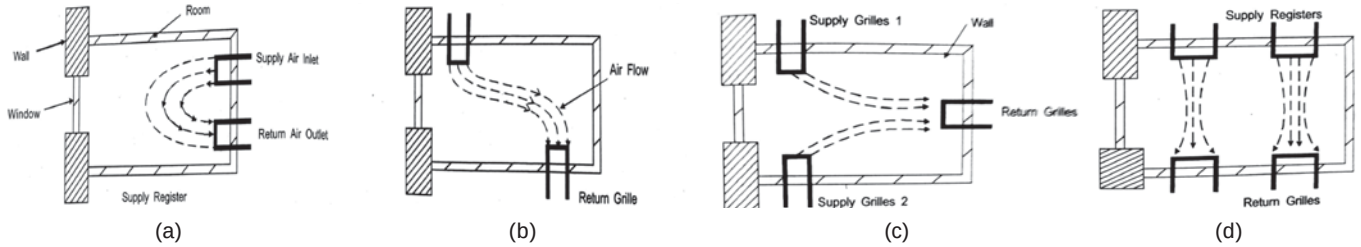


Figure 16.1: Air Distribution Combination

differ to large extent from the temperature of the room. Several arrangements of supply and return air are shown in figure 16.1 (A, B, C, D).

The system shown in the figure A is used mostly for summer air conditioning. The supply and return grilles are located on the same wall. This system is cheaper to construct.

The system shown in figure B is used to provide uniform supply and prevent downward reverse current. The supply and the return grilles are located on different walls. This system can create a stagnant space below the supply outlet.

The system shown in figure C is the "pan type" air distribution system. This is efficient and ensures air circulation throughout the space.

The system shown in the figure D is preferred for heating, i.e. winter air-conditioning. Here, two supply register and two return grilles are used to provide a cross draft.

Sometimes, perforated ceilings are used and return ducts are placed on floor level. The drawback is the high cost of the system. This system is preferred where ceiling height is less as shown in figure 16.2

Factors affecting air distribution are:

1. Size of the duct
2. Velocity of the air in the duct
3. Location of grilles & diffusers
4. Flow pattern of air in the room
5. Entertainment of room air

Ventilation Systems

Ventilation system is used for spaces where only exchange of air with the surrounding is desired. The application area may be a subway or an underground outlet or a building kitchen. The air in the application area is not conditioned for human comfort. The amount of ventilation air depends on the occupancy of space or the area and the heat load of the space. There are two types of ventilation systems. There are: (1) Natural Ventilation (2) Mechanical Ventilation.

Natural ventilation makes use of wind flowing due to the pressure difference between the application area and the surrounding. This is similar to natural draught in a chimney. There is no control over the flow and dust particles from the surrounding may enter ventilated space. That is why this system is not preferred for commercial application and is only used where low cost is desired.

Mechanical ventilation uses a fan to ventilation space. The quantity of flow and direction of flow is controlled by fan. Mechanical ventilation systems are further classified as extraction, supply or combined supply-extraction system.

In extraction system, a fan sucks out air from the application area. This is the most widely used method. It is similar to induced draught system. The effectiveness of extraction depends on location of air inlets in the ventilated space. In supply systems, a fan forces air to the ventilation area. It is similar to a forced draught system. A positive pressure gradient is maintained in the conditioned space. In combined system, fans suck air from the room and supply air to the room. This is

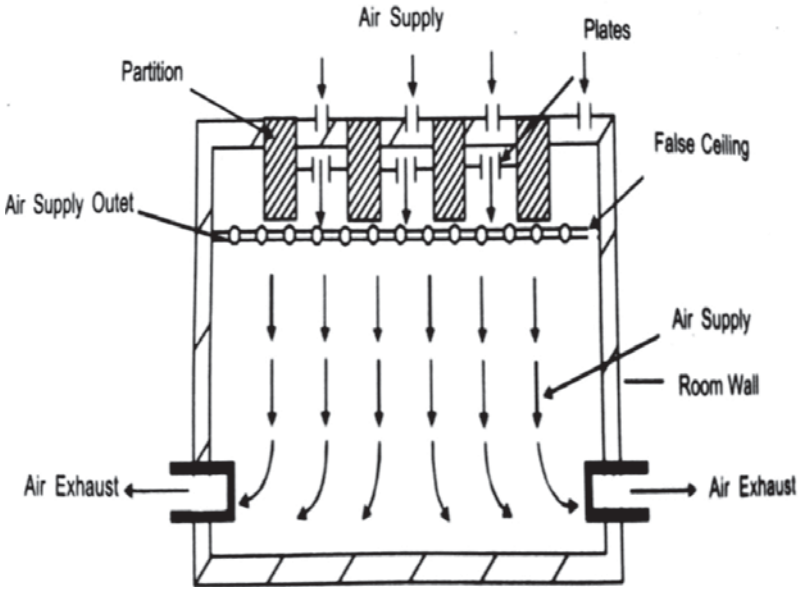


Fig 16.2: Perforated Ceiling System

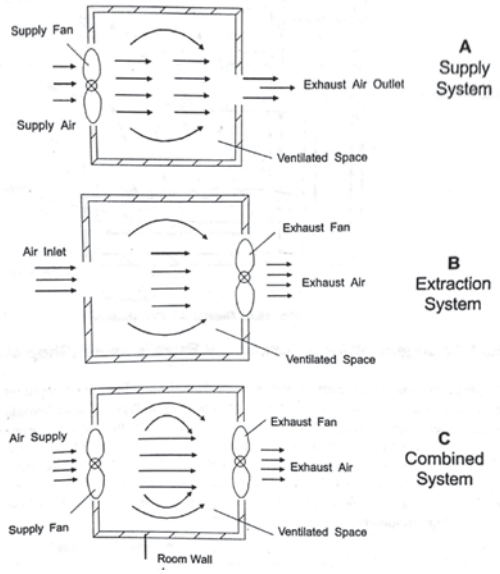


Fig. 16.3: Mechanical Ventilation System

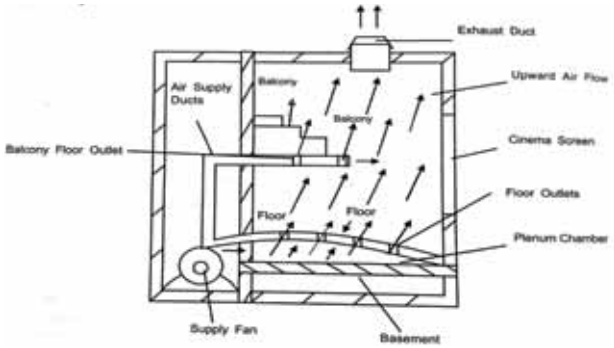


Fig. 16.4: Theatre Air Distribution

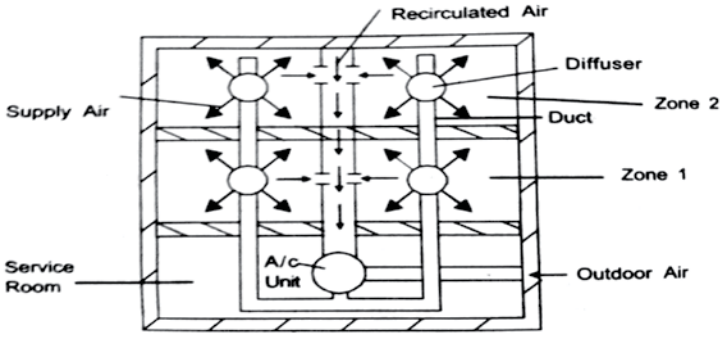


Fig. 16.5: Duct Layout for a Shop/Mall

similar to balanced draught. Fresh air can be conditioned in the system. However, the possibility of air short-circuiting the ventilated space exists. Figure 16.3 shows three types of mechanical ventilation systems, i.e. the supply, the extraction and the combined system.

Air Conditioned for a Theatre

Figure 16.4 shows the air distribution system for a theatre. The air distribution shown is the upward air flow system. A downward system is also possible. In the upward flow system, air enters the theatre through inlets near the floor of the theatre. The air flows upwards. The exhaust grill is locked at the top in the ceiling. The advantage of the system is that air enters the theatre, collects heat from the occupants light and equipment becomes hot and rises upwards. The movement upward is aided by lower density of hot air. This system also removes bad odours from the conditioned space. This system is suited for winter or summer air-conditioning.

Duct Arrangement for a Commercial Establishment (Shop/Mall)

The duct systems, which carry conditioned air from the conditioning equipment to the conditioned space and back, are designed in specific patterns. Several types of duct layout are available as perimeter loop, radial perimeter system or extended plenum system figure 16.5 shows one such extended plenum system for a shop or a commercial mall. In this system, the conditioner is located in one corner of the mall. Two branch ducts run along the length of the rooms. Four diffuser, usually in a rectangular pattern, are located in four corners of each zone. The return air duct is located in the centre of the zone. The outside air duct is located close to the air conditioning equipment as shown in figure 16.5. ■

Dr. Dlilp M Patel
Principal
Swaminarayan College of Engineering and Technology

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Indoor Air Quality Monitor Market worth USD 4.63 bn by 2022

The rising demand for indoor air quality monitoring products is due to the increasing adoption of smart home & green building technologies, growing consumer preference for pollution-free indoor environments, and development and commercialisation of innovative wearable air-quality monitoring devices...

According to the new market research report, the market is expected to grow from USD 2.52 billion in 2015 to USD 4.63 billion by 2022, at a CAGR of 9.22% between 2016 and 2022. The rising demand for indoor air quality monitoring products is due to the increasing adoption of smart home & green-building technologies, growing consumer preference for pollution-free indoor environments, and development and commercialization of innovative wearable air-quality monitoring devices.

On the basis of product, the global air indoor quality monitor market has been segmented into fixed and portable indoor monitors. The market for portable indoor monitors is expected to grow at the highest rate during the forecast period. The market growth can be attributed to the increasing adoption of smart homes and green-building technologies (including effective ventilation, air quality monitoring and control, and indoor dust & gas level management) and growing consumer preference for healthy and pollution-free indoor environments.

Chemical pollutants accounted for the largest share of the global indoor air quality monitor market in 2015. This can be attributed to factors such as the increasing number of stringent government regulations for effective monitoring and control of industrial exhausts, growing public concerns about the health implications of air pollution, and ongoing development and commercialization of innovative gas and chemical detection sensors.

Government buildings accounted for the largest share of the overall indoor air quality monitor market in 2015. This can be attributed to the increasing focus of governments toward green buildings and growing health concerns due to rising air pollution. The governments in the countries such as the US, the UK, and China, among others, have made stringent regulations for air pollution monitoring and have released funding for installing air quality monitors within their premises for continuous monitoring.

North America is expected to hold the largest size of the indoor air quality monitor market during the forecast period. North America is a mature market, with the high penetration of advanced pollution monitoring technologies and the presence of well-established distribution channels for the supply of indoor air quality monitoring products. The US is expected to dominate the market in this region in 2016. The market growth in the US can be attributed to the significantly large end-user base for industrial and indoor air pollution monitoring products in the country compared to Canada. The major factors driving the growth of the market in the US include significant public-private funding and investments to support air pollution monitoring-based researches and ongoing technological advancements in the field of gas analyzers and particulate sensors. ■

Efficient Facility Management for Measuring Tasks

Technical facility management is about creating an indoor climate that guarantees a healthy working atmosphere and optimum production quality. However, the energy consumption and operating costs of buildings need to be kept as low as possible. Digital measuring instruments and sensors help to check the air quality and optimize ventilation systems, adjust heating, refrigeration and air conditioning systems efficiently and maintain electrical installations.

These are the tasks of your service engineers, who often work in a wide variety of buildings using different measuring instruments. One of the key tasks of the head of technical facility management is to maintain an overview of the staff, measuring technology and measurement data and to minimize the amount of work and material required.

Testo is a strong partner to have by your side, who will provide you with all the measuring equipment that you need to carry out all your facility management tasks. However, you also obtain a tailored service to make your work easier, more accurate and faster, and actively help you to optimize your field service processes. Not only are the measuring instruments easy and intuitive to operate thanks to user-specific apps and menus, but the documentation process is also considerably easier thanks to digital recording. For better, more efficient facility management.

Challenge

Not only do facility management companies often employ dozens or even hundreds of service engineers. For the many different measuring tasks involved in facility management, numerous instruments are also required, and these are purchased from a wide range of manufacturers. When it comes to managing the test equipment, the procurement, maintenance and calibration of the technical instruments entails a huge amount of organization. The many different operating and software concepts also make it difficult for service engineers to handle the instruments. The measurement applications, therefore, take longer.

Inexperienced or less qualified employees are not capable of interpreting the readings correctly or of taking the requisite measures. Moreover, measuring instruments are often not available at all, because they have just been sent in for calibration, or the recorded data is stored on different platforms and needs to be merged, which is a laborious procedure. The required documentation takes a lot of time and entails avoidable costs.

Solution

Testo offers you a tailor-made complete package for technical

facility management – digital measuring instruments, innovative software and application-specific apps for the documentation and digital storage of recorded data. You no longer need to spend a lot of time selecting and purchasing measuring instruments from different manufacturers. At Testo, you can get a wide range of instruments which no other measurement technology manufacturer can offer you, all from one provider. We offer reliable, digital measuring instruments for the optimization of ventilation systems, for checking ventilation and heating systems, for the efficient adjustment of refrigeration and air conditioning systems for the maintenance of electrical installations for the accurate detection of thermal bridges and weak spots in buildings and also for the reliable identification of the causes of mould. Since Testo measuring instruments can cover multiple application areas, the service engineer can work more efficiently because not only do the instruments have an app connection, they also feature similar intuitive operation. This reduces the time needed to train new employees and also reduces the error rate.

Since lots of instruments have wireless sensors, the readings can be ascertained easily and reliably. The measurement results can be determined quickly and easily and sent directly to the customer or the head office in the form of reports, including digital images and commentary. This saves a lot of time working on site: With Testo's measurement solutions, a measurement job that previously took over an hour can be completed in less than 45 minutes.

Advantages at a Glance

- "One-Stop Partner": all the measuring technology you need for all your facility management tasks, from just one provider
- Greater efficiency when managing test and measuring equipment
- Save time and money: faster measurement applications and digital measurement data documentation
- Reliable compliance with the ISO-9001 standard thanks to digital recording and traceability of all processes. ■

Courtesy: Testo India

Enhancing Efficiency of Blower

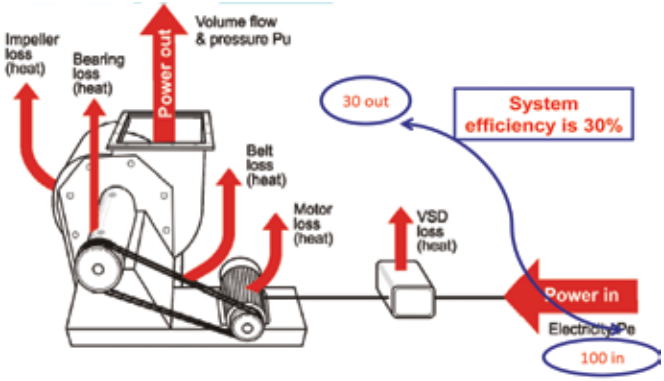
Blower system which consumes at the input as 100 units, delivers only 30 units at the output. In your industry, give a macro view to your existing fan as a system. Study whether you can retrofit, replace the sub system components to reduce the overall energy loss by 10 % conservatively, by low to medium cost energy conservation measures...

Picture Courtesy: Efficiency in New Dimensions, ebm-papst, RadiPac EC centrifugal fans for air handling units (AHU)

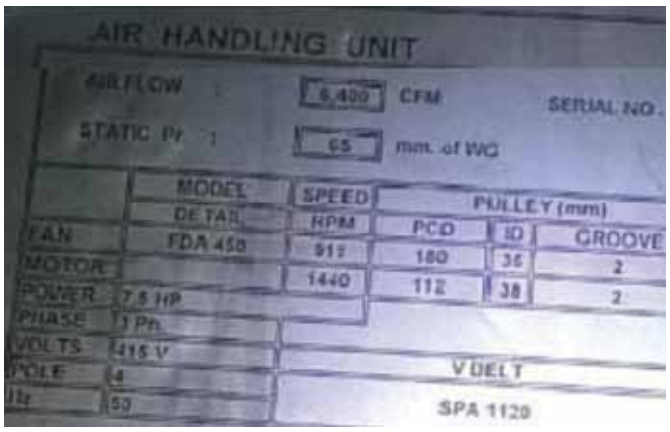
The industry is using the centrifugal blower in many of the process in the production and in utility. As a system, the centrifugal blower system efficiency is the multiplied efficiencies of each of the sub systems like the motor, VFD, belt, pulley & drive, and the main impeller. Hence, your blower system which consumes at the input as 100 units, delivers only 30 units at the output.

The blowers are used in various applications in the industry like the air handling units, air washers, dust collection system, waste evacuation system, material handling / transport systems etc. The above applications call for the basic two parameters, the deliverable air / gas flow at what static pressure. This paper elaborates on the efficiency in per cent in each of the sub system so as to achieve reduction in their self-consumption energy

System Energy losses viewed from Input KW to motor



I image – Around 30 % only is the deliverable AHU output, as sub systems are energy in-efficient.



II image – AHU name plate spec and study the specs and to assess the loss between the cup & the lip.

55 KW (75 HP) CENTRIFUGAL BACKWARD BLOWER SYSTEM EFFICIENCY IMPROVEMENTS

Centrifugal Backward Existing Fan Efficiency	VFD Effy %	Motor Effy %	Belt & Bearing Pulley Effy %	Fan Effy %	System Effy. %	System Energy Loss %	Remarks-Ways to Improve in each sub system and overall Effy improvements Possible in low & high cost.
Old Backward Inclined Flat profile	98	90	90 (case study)	78	62	38	Std motor many times Rewound, VFD, loose V belts, Backward but Less Efficient Flat blades
New Backward Curved /Near to Air foil profile, with all Efficient Sub system Retrofit	98	94	98	85	77	23	Changed to IE 3 motor, REC belt & matched pulley drive, Efficient Curved (near to Airfoil for clean environments like Air conditioning AHU

loss and hence improve the overall blower system efficiency.

Existing Industry Blowers' Working

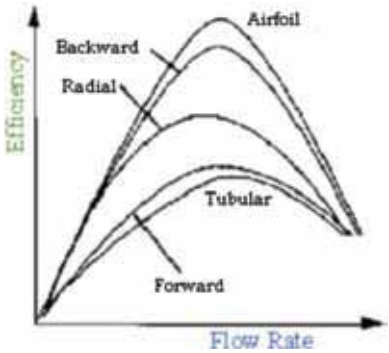
Existing fan delivers here, output as 60 % of input only due to Cup & Lip Energy losses in between. All the sub-systems can be improved upon to reduce the energy losses by half from now on.

Centrifugal Backward Inclined Flat / Curved Impeller

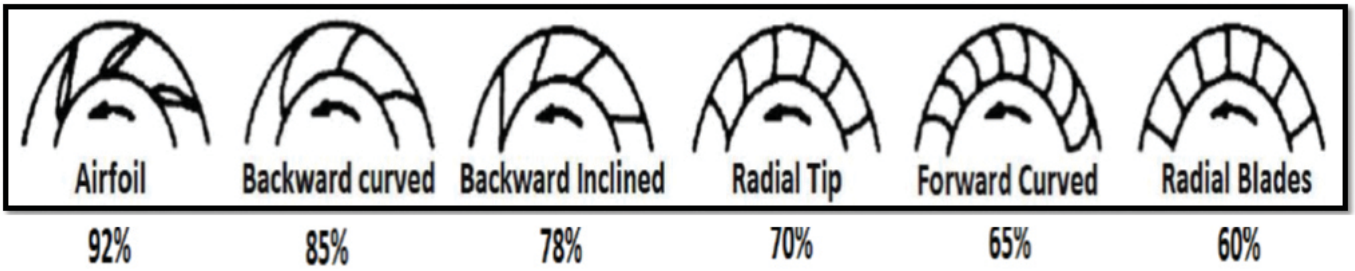
- Previously, the MOC, the Material of Construction of the Impeller, weight also was prohibiting the impeller profile & efficiency. Impeller with aluminum MOC is changed now to the airfoil profile with less weight M S sheet MOC and this yielded higher efficiency due to Impeller profile change.
- Old timer OEM contentedly designed the impeller with backward inclined flat profile and later the fan OEM changed over to backward curved profile to air foil profile. This air foil type suits to clean air applications and environments.
- The centrifugal backward curved fans generally have a non-overloading power characteristic; the backward-inclined blades are flat and have constant thickness. Backward-curved blades are slightly curved. Air foil blades are generally formed from hollow sheet metal to meet the shape.
- So, as per BEE's table, the existing fan blades are having efficiency from 72 to 79 % band to 79 to 83 per cent band depending on the profile designed by the OEM as modified radial blade design to inclined flat to curved design, that is more near to airfoil design, delivering highest efficiency.
- The modified radial blades are radial to the fan shaft at the outer end of the impeller, but gradually slope towards the direction of wheel rotation. They are more efficient than the radial blade but less than backward inclined profile.
- The efficiency versus flow curve of the above fans indicates that the best operating point or the peak efficiency point is achieved in narrow band only and is not a wide band characteristic.
- So, you, the buyer industry, when newly buying this above type of

Fan Efficiencies

Type of Fan	Peak Efficiency Range
Centrifugal Fans	
Airfoil, backward curved / inclied	79 – 83
Modified radial	72 – 79
Radial	69 – 75
Pressure blower	58 – 68
Forward curved	60 - 65



Courtesy: Bureau of Energy Efficiency Guide books, Fans & Blowers chapter.



Courtesy : Peak Efficiency Pt. of Centrifugal Backward Fans & Blowers by Prof H Q Nagpurwala.

centrifugal backward impeller, ask the OEM to give fan flow versus static pressure profile band to know where is your peak point

- Today re-visit to your industry's running fan and confirm that you are using the highest / high / moderate efficiency fan. Because that was bought few years back, based on its initial costing.
- In your waste suction blower, take steps to expand the blower outlet duct as your existing blower is wasting its static pressure by way of higher back pressure, curbing its system efficiency.

VFD TO Function Fully in Blower

- Since the VFD is fitted to your blower, we have to take into account, the self loss of the VFD as 2 %. So, it is always preferred to operate your VFD in part loading say between 30 to 80 % band and not in full loading and above as 90 to 120 % band etc.
- You are using the VFD to match your blower design parameters to the process parameters like temperature, pressure, RH, etc. Some industries are using VFD to the blower for the purpose of variable pulley function only and routinely manually set VFD Hz settings to match process flow.
- Your VFD can be put to full use only if the VFD controls automatically the blower RPM to suit to process flow by way of closed loop function and the sensor say like temperature, RH, static pressure in case of Air Handling Units (AHU), Air Washer utility. For material handling function of powders etc, static pressure is the key parameter to be controlled and sensor is chosen rightly.

Belt & Pulley Drive Losses Are More Than Expected Now

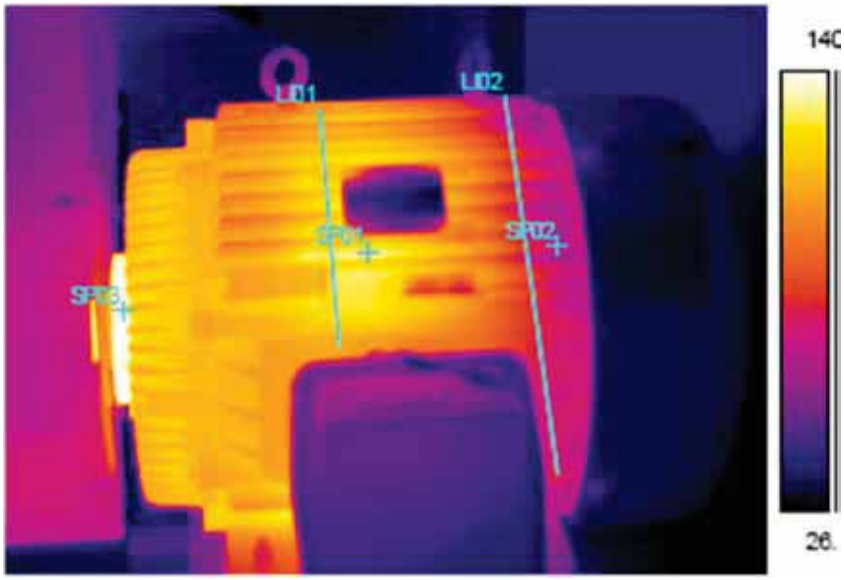
- If your belts are actively gripping the pulley, then you are maximizing your belt transmission efficiency. If your belts are only passively touching the pulley, then your belts & pulley consume more power and less belt transmission efficiency now.
- The industry must visualize today, the visible loss in their belts and pulleys. If you change your V belt today to raw edged cogged REC belt, this transmits power without loss, compared to the V belt to deliver near the rated Revolutions per Minute (RPM) and hence, it gives you more productivity. Simultaneously, if you optimize the 'motor & load's pulley size to suit to the same output as load RPM, then it is power saving for you.
- This comparison table of same type of centrifugal backward curved fans is informative and you the buyer have to use this table in your new buy or existing fan to assess its system efficiency.
- So, focus on belt & pulley change today (and not only the belts only as a routine change), and anticipate more

2 grooved Motor pulley weighs 5 Kg linked by 2 belts in 8 grooved m/c pulley weighs 20 Kg. This excess weight of machine / motor pulley will consume more KW. Match belt & groove numbers.

Fan type		Centrifugal	Centrifugal
Impeller Type		SISW	SISW
Drive arrangement		Direct Drive	Direct Drive
Volume flow	m3/hr	9000	9000
Static Discharge @ 20 Deg C	mmwc	275	263
Dynamic Pressure @ 20 Deg C	mmwc	37	7
Total pressure @ 20 Deg C	mmwc	312	270
Static Discharge @ 45 Deg C	mmwc	250	250
Dynamic Pressure @ 45 Deg C	mmwc	38	6
Total pressure @ 45 Deg C	mmwc	288	256
Operating temperature	°C	20	20
Altitude in metres	m	275	275
Density at Inlet @ 20 Deg C	kg/m3	1.2	1.2
Fan shaft power @ 20 Deg C	kW	11.4	9.4
Density at Inlet @ 45 Deg C	kg/m3	1.09	1.078
Fan speed	RPM	2920	2930
Fan shaft power at operating density	kW	10.4	8.31
Fan Static efficiency	%	59%	69%
Total efficiency		68%	76%
Min. recommended motor rating	kW	11	11

Centrifugal backward curved fans efficiency comparison will indicate the Total Owning cost Fan Total Efficiency = Volume in m3/sec X Total pressure in mmWC / 102 x Power input to Shaft KW Calculate above two fans' efficiency as 68 % and 76 % and use this formula to know about your fans.

MOTOR HOT SPOTS IN BEARINGS DE & NDE DE - Drive End Bearing 140 * C
NDE - Non Drive End Bearing 60 *C



Waste collection Suction centrifugal blower rating 55 KW, 75000 CFM flow @ 2200 Pascal.

Waste collection Suction centrifugal blower rating 55 KW, 75000 CFM flow @ 2200 Pascal.

productivity at less power consumption. When the belt numbers are halved, physically down-size the pulley grooves say from 4 to 2 grooves thereby, power saving is achieved here by material conservation.

- Universally, the rotating components either active / passive, need to have less weight only. Excess rotating mass consumes more energy only and that is not useful to the motor-to-machine power transmission. Direct coupling also will solve the above problems, but this as well has its inherent slight drawbacks. Normally, OEM uses belt as weak link of transmission when their sturdy machine and motor are linked, and each of them not to mismatch each, even instantly also.

Hot Motors Run Hotter

- We still have decades-old multiple times-rewound (count-less rewinding) motors running hotter at normal loading, overloading, repeated greasing with conventional grease over & above the existing grease not allowing to drain out the old worn-out grease, DE & NDE bearing ends show temperature difference of say, more than 20 Degree C displayed by the portable thermal imager.
- Monitor your motor with power & energy metering and target the above causes of hotter motor. And after trying all the above zero and low cost measures on the motor, it is time to wake up to switch over to IE 3 motor now. Be aware that the IE 3 motors growth is likely to double in 2019 with reference to 2014 in the world industry. And that IE 1 motor's growth is getting halved now. In India, it is already in the Gazette to change to minimum IE 2 motors from 2018 onwards.
- Routinely use your thermal imager to assess your motor & machine health. Spot out the hot spot in motor and try ways to reduce the heat. Hotter motor is due to overloading, current unbalance, sticky or over-greased bearings, (many industries have switched over to specialty grease as Polyurea thickened Lithium complex compound now), poor lubrication & starved ventilation, alignment problems, repeated re-windings, lower than rated volts, hotter windings due to VFD input to your standard conventional motor.

Conclusion

In your industry, give a macro view to your existing fan as a system. Study whether you can retrofit, replace the sub system components to reduce the overall energy loss by 10 per cent conservatively, by low to medium cost energy conservation measures. The above is in line with energy conservation route in the existing centrifugal backward fan system.

Also look into your process requirements and plan for energy efficiency option route by changing the total system to electronically commutated EC Multiple BLDC fans to achieve more than 50 % energy savings as a total system change. This is similar to the exercise of replacing our CFL / FTL to the LED tube lights, as energy efficiency route. If you see the total owning cost of the fan for its life say 10 years, EE route is always better than the ECON route, barring the initial huge costs involved. ■

Ashok Sethuraman
BEE Accredited Energy Auditor,
Coimbatore

Selecting Efficient Pump

If we are talking about commercial buildings, most of the applications are clear water pumping. It means there is hardly any wear and tear to the impeller or casing due to fluid characteristics. The major reason of these inefficiencies is less knowledge about the pump's characteristics and sizing...

Wherever we go, whether an industry, a commercial building or even a residence centrifugal pump is going to be the most common equipment all over. We can't imagine any facility without a pump. It is there, for simple water supply application to even a complex structure like HVAC and even process heating and cooling.

Like every other electrical moving equipment pump is also meant to follow a definite path during its performance. It will not be exaggerated if we say it is the most systematic electrical moving equipment. If it is designed to follow a specific path then why it is not running at its best efficiency? Studies shows, in an air-conditioned commercial building about 20% electricity is consumed by pumps. The important thing here is that most of these pumps are working with pump efficiencies not more than 55%, whereas these pumps are designed to run with 70% or more efficiency. It means the consumption of pump is nearly 15% higher than what it should be. Studies shows that most of the people/facility operators are even not aware about the technical reasons behind this. If we ask people about the reasons of these lower efficiency operation we will get a very common answer "these are very old pumps". Is it really so? According to manual on *Operation And Maintenance Of Water Supply Systems* prepared by Central Public Health and Environmental Engineering Organization, Ministry of Urban Development New Delhi the normal life of a centrifugal pump is 15 to 20 years. If we are talking about commercial buildings most of the applications are clear water pumping. It means there is hardly any wear and tear to the impeller or casing due to fluid characteristics. The major reason of these inefficiencies is less knowledge about the pump's characteristics and sizing.

Figure 1 shows a typical characteristic curve of a centrifugal pump.

The simple interpretation of this curve is,

1. As flow increases head reduces and vice versa.
2. Pump can deliver a flow/head higher or lower than mentioned over its nameplate (thus nameplate parameters are not rated parameters. It is duty point to achieve best efficiency).
3. Unless and until there is wear and tear of pump parts, speed change or change in system, pump is meant to follow these characteristics.

If operating conditions matches the duty point conditions then pump will run at its best efficiency. Now let's discuss why the pumps do not work at their best efficiency?

People might understood the pump curve/characteristic and select a good

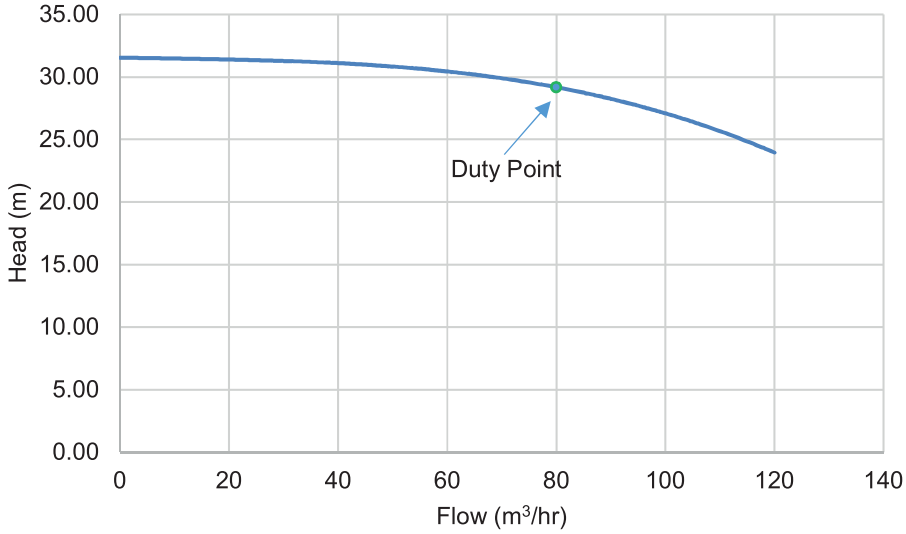


Figure 1: Typical Pump Curve

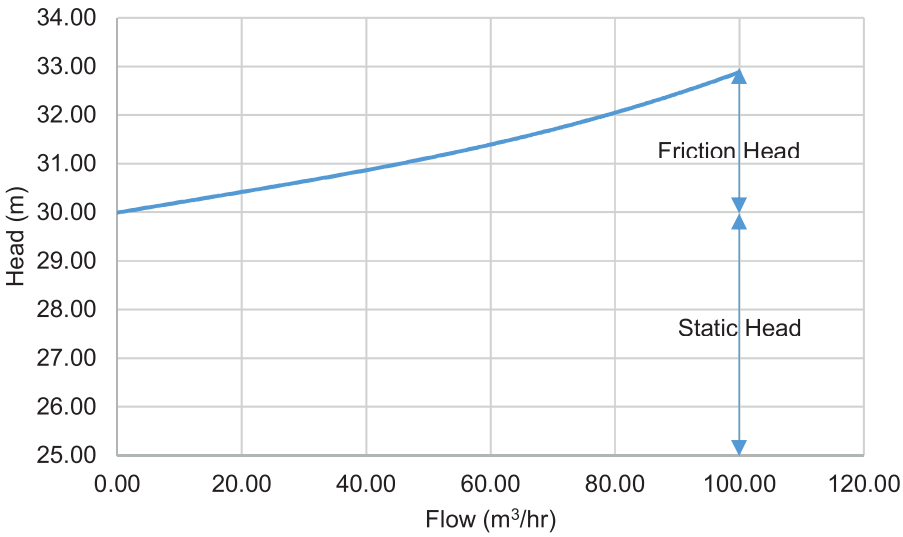


Figure 2: System Curve

pump but they mostly forget about the system. What is system? System is the flow network consisting of pipe, bends, joints and valves. System also has its own characteristics. Pump manufacturers do not provide system characteristics. It is to be taken into account by the pump user. Figure 2 shows a system curve.

It is having static head and friction head. Static head is the effective straight height or it can even be the pressure drop across process/utility (like chiller, plate heat exchanger) against which liquid is to be pumped. Friction head is the frictional loss occurring while the liquid is moving through the piping network.

What flow and head the pump will deliver is decided by the system. The pump just has to overcome the system resistance (or say head) to deliver the required flow. System curve will help user to identify respective system head for his/her required flow. For example, if user want a flow 80 m^3/hr, he/she has to maintain a head of 32 m (see figure 2). Thus, the point of intersection of pump curve and system curve will decide the operating point of pump. It means if you have a pump of 80 m^3/hr flow and 29-meter head but if your system head is more or less than this then the pump is not going to deliver 80 m^3/hr at all. Let's consider following case.

User need a flow of 80 m^3/hr. As per system (see figure 2) head required for this flow is 32 m. If user has selected a pump of duty point 80 m^3/hr and 29 m head; then the pump will be operated as shown in Figure 3.

Blue point indicates the Duty Point of pump and green point indicates the Operating Point. User selected a pump of desired flow of 80 m^3/hr. However, he neglected the system requirements and wrongly selected the head. Due to which the instead of working on duty point, now pump is operating with some different flow and head which is not giving the best efficiency.

Thus, the system head is going to decide how the pump is going to operate, no matter what specifications we have selected for pump. Therefore, before selecting a pump, we should know what the system head is. How many of us are aware about our system head? Some people says my pump is designed for 100 m^3/hr. But it is delivering only 60 m^3/hr it means it is 60% efficient only and this may be due aging or bad selection. But it's not the case. It is only because we ignore the system head.

We have seen that in order to select a pump we should know the system curve or at least system requirement. Then how to draw a system curve? If we have the piping design software and exact piping details (like diameter, length, height, number of bends, valves etc), then it is easy to design a system curve. Exact piping details can only be available if the project is under design or construction phase or the system is too simple like shown in the figure 4.

For a simple system as shows in figure-4, it is very easy to physically measure the static head, pipe diameter and pipe length also.

But if the system is a complex one, e.g. an old HVAC system, then it is very difficult to physically measure the pipe length. If you wish to replace the old pump in such system with a new pump, then it is very difficult to identify the system head requirement. Estimation may end up into wrong pump selection and loosing on the pumping efficiency.

With some experiment and mathematics, it is possible to calculate the

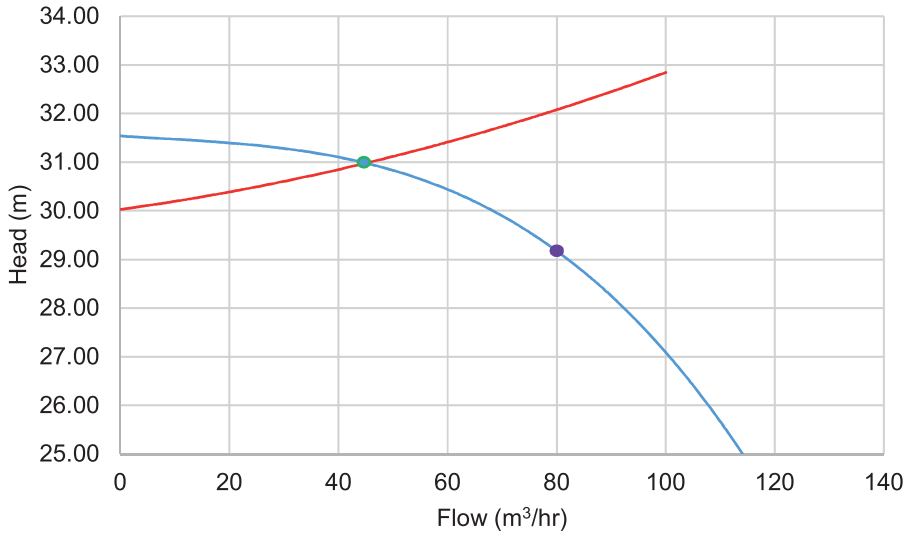


Figure 3: Duty Point and Operating Point

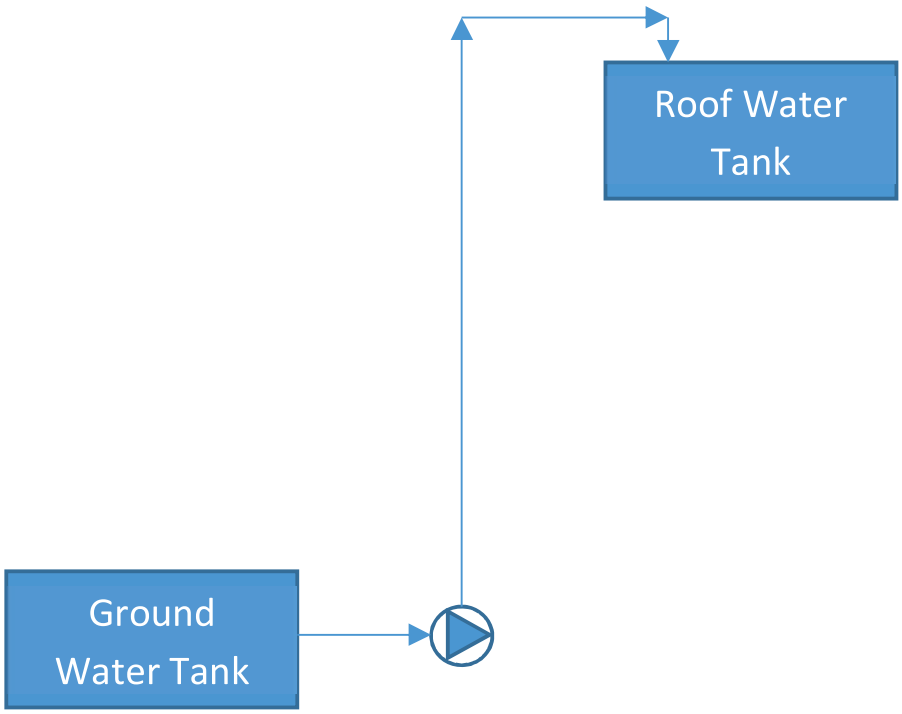


Figure 4: System

system head for a particular flow requirement. The experiment and mathematical calculations and explained further.

Calculating System Requirements for an Existing Complex System

Let's consider that the existing pump in a complex HVAC system is not working at its best efficiency and therefore, it is intended to replace this pump with a new efficient pump. The flow requirement is 500 m3/hr. In order to select an efficient pump, it is important to know the system head for 500 m3/hr flow. The system head can be evaluated by performing following experiment.

Step 1: Install new calibrated pressure gauges on the suction and discharge side of pump.

Step 2: Install an ultrasonic water flow meter at the discharge of pump to measure the velocity and flow.

Step 3: Start the pumps with discharge valve 100% open. Measure the suction head, discharge head and discharge water velocity.

Step 4: Calculate total head for Step 3.

Step 5: Throttle the discharge valve for 50%. Measure the suction head, discharge head and discharge water velocity.

Step 6: Calculate total head for Step 5.

$H_T = H_S + H_F$ (equitation 1)

Where,

H_T : Total head

H_S : Suction Head

H_F : Frictional Head

Frictional head can be calculated using following formula

$H_F = (F) \times (L/D) \times (V^2/2g)$ (equitation 2)

Where,

F : Friction factor related to the roughness inside the pipe

L : Length of the pipe

D : Diameter of the pipe

V : Average liquid velocity in the pipe

g : Gravitation acceleration constant

In equation 2 most of the parameters are constant except velocity. Thus equation 2 can be rewritten as,

$H_F = K \times V^2$ (equitation 3)

Where, K is constant.

So, the equation 1 can be rewritten as

$H_T = H_S + K \times V^2$ (equitation 4)

Condition 1: Discharge Valve 100% open

As per the experiment conditions

$H_{T1} = H_S + K \times V_1^2$ (equitation 5)

In equation 5, H_{T1} and V_1 are known factors.

Condition 2: Discharge Valve 50% open

As per the experiment conditions

$H_{T2} = H_S + (1/0.5) \times K \times V_2^2$ (equitation 6)

In equation 6, H_{T2}, and V_2 are known factors. Because of 50% throttling the discharge diameter of pipe will be half of earlier diameter.

If we subtract equation 5 from equation 6 then we will get "K".

By using value of "K" in equation 5, "H_S" can be calculated.

Once "H_S" and "K" are known, we can calculate system total head for any flow required or even can plot a system curve (using equation 4). Using values of "H_S", "K" and the required flow of 500 m^3/hr total head requirement of the system can be calculated and then the pump can be selected. As this head, pump for 500 m^3/hr will match with the system requirement and will operate at its best efficiency.

This method gives better results than estimations and helps to select a pump which would operate at its best efficiency. ■

Manoj Telrandhe
Certified Energy Auditor
Accredited Energy Auditor
Certified Measurement & Verification Professional

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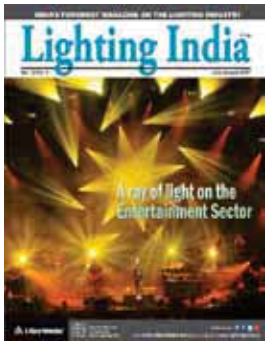

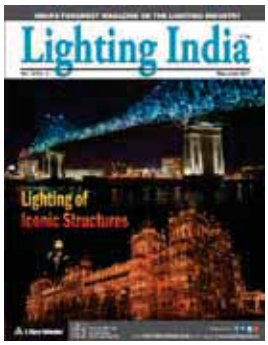

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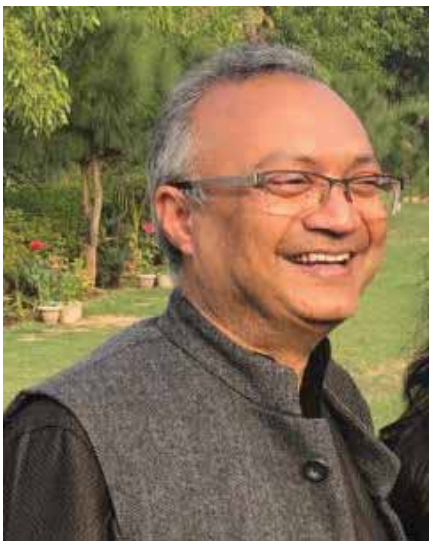


"Awareness about air quality is becoming very prominent in India"

The Indoor Air Quality Association or IAQA is an international trade group dedicated to bringing practitioners together to prevent and solve indoor environmental problems for the benefit of customers and the public. IAQA intends to continue its mission of bringing practitioners together to prevent and solve indoor environmental problems for the benefit of customers and the public in every corner of the globe, informs **Richie Mittal, Chapter Director, IAQA – India** in an interaction with **Cooling India**...

Kindly give a brief on your organization and activities?

The Indoor Air Quality Association or IAQA is an international trade group dedicated to bringing practitioners together to prevent and solve indoor environmental problems for the benefit of customers and the public. Established in 1995, the IAQA is the only professional organization that focuses on and connects the many facets of the indoor air quality (IAQ) industry. IAQA's domestic and international membership is made up of thousands of individuals and companies from various industry verticals including contractors, consultants, facility maintenance professionals, industry vendors, school officials, researchers and representatives government agencies. IAQA provides education for all parts of the IAQ industry, translating science and standards into practice, properly informing consumers, and bringing critical feedback to industry leaders. The membership benefits are too numerous to share in this venue. But, IAQA members enjoy weekly email updates in IAQ related topics, quarterly educational e-newsletters, Chapter educational programs, 50+ IAQA University on-line courses, monthly technical webinars, Annual Meeting packed with presentations and discussion panels, industry product discount programs, opportunities to work cooperatively with partner organizations, on line business referrals and so more.

IAQA's India Chapter is just over one year old but has a powerful nucleus. The India Chapter of the IAQA and the local members of the association are hard at work achieving the IAQA mission throughout the country and beyond. IAQA India Chapter is jointly working with the relevant authorities and associate societies to promote awareness and solutions to public at large.

What do you feel about your presence in India and how does it help your members?

Broadly speaking, there are numerous positive effects any time you can gather industry professionals from the various air quality related disciplines. The exchange of ideas, the networking connections made and the camaraderie of colleagues are all positive outcomes from this event.

How do you look at India as a marketplace for your offerings and future plans?

The desire to provide quality indoor environments is not specific to any nation. However, India is facing major issues with outdoor and indoor air quality in metro cities and IAQA intends to continue its mission of bringing practitioners together to prevent and solve indoor environmental problems for the benefit of customers and the public in every corner of the globe. With the growth of the IAQA Chapter in India, we expect opportunities for our local members to be ever increasing.

India is fastest growing economy your views?

Awareness about air quality is becoming very prominent in India and resulting in big opportunities. And, IAQA wants to be on the scene to ensure a quality indoor environment is considered and delivered for the buildings existing today and for the buildings planned for the future to accommodate India's growing economy. ■

Post-Harvest Management of Horticulture Produce

All Post-Harvest Management (PHM) development must be with the prime aim to generate improved value realisation for farmers, by enabling them with a choice of markets, across larger geographies and by reducing losses in the supply chain. Capacity building is needed so that PHM development is projectised, optimally across a series of market linking activities...

India is bestowed with varied climate which ensures availability of fresh fruits and vegetables round the year. Though the country ranks second in production of fruits and vegetables in the world after China, the development of its supply chain was not strategically directed, for safe handling and to convey these perishable products to markets. A resultant

demand supply mismatch has emerged for perishable produce, which contributes toprice fluctuations and inflation. The inadequacy of technology aided farm-to-market logistics, also contributes to high losses in perishables, further adding to inflationary pressures and lowered value realization for farmers.

Developing efficient post-harvest management for horticultural produce has become a necessity, if we are to bring greater value to famers, reduce food loss, ensure nutritional security, reduce inflation and meet our sustainable development goals.

Post-harvest activities are an integral part of the food production system, and its aim is to safe-guard the harvested value, extend its reach to market and empower the farmers with a choice of market. PHM enables this through a broad spectrum of operations that promote better practices in post-harvest handling and business linked management along the entire food supply chain. Efficient PHM extends the marketable life of fresh food, and in doing so, it allows more time for the produce to reach more markets, all the while maintaining freshness and quality. Most importantly, the system helps to link the farmers higher up in the value chain cycle, for maximum benefit and increase in their income.

All forms of post-harvest management, especially, cold-chain, has a transformational impact on how farmers access and interact with markets. A working knowledge and understanding of the technical factors that impact on the safety, quality and value of agricultural produce, appropriate infrastructural support base, effective logistical networks, structured stakeholder interactions within post-harvest supply chains, and strategic government direction with allied support services are some synergistic prerequisites.

Major impediments to Post-Harvest Management

Post-harvest management infers that production become market linked. Therefore, it requires that the type of crop, its planting material, harvest cycles and times, the pre-conditioning and dispatch of produce, should be decided on the basis of predetermined destination points. Such decision making is optimally initiated at the first point consolidation, at source point, which is the modern pack-house. Developing such pack-houses effectively means developing the nerve centre of the fresh food supply chain. However, there are certain bottlenecks to such development -

1. Lack of technical training/extension facilities available to horticulture farmers; the focus on horticulture has been less than on traditional agriculture, even though horticulture is high value agriculture (HVA).
2. Matching infrastructure with cultivators' capacity; PHM infrastructure needs to be developed ahead of other production linked development, such as FPOs, cooperatives, etc. This adds a gestation period on the investment, until economy of scale is achieved.
3. Lack of market-linked quality indices – which impacts choice of type, stage of maturity for time and method of harvest; while the consumer is quality conscious, a scientific methodology or quality matrix is yet to be developed.
4. Lack of pack-house facilities also stems from a lack of relevant farm-to-market transport options; while a farm-gate PHM centre enables the produce to travel longer distances to more valuable markets, the lack of railways, reefer vehicles and waterways modes makes the efforts redundant.

In essence, there exists a need to have more cohesive strategies that add greater focus on high value agriculture with an approach to link farmers directly with national level markets. This includes

Table 1: Overall status of cold chain infrastructure and requirement

Sr. No.	Infrastructure Component	Existing Capacity (2014)	Approximate Requirement
1	Integrated Pack Houses	250 numbers	70,000 numbers
2	Reefer Transport	<10,000 numbers	62,000 numbers
3	Cold stores (Bulk, CA enabled & distribution hubs)	32 million tonnes	35 million tonnes
4	Ripening Chambers	800 numbers	9000 numbers

developing the right kind of cultivars and planting material, providing appropriate capacity building and market linked extension services, creation of post-harvest infrastructure to directly connect farmers with wholesale markets and provide fiscal and financial incentives for the private sector to interact with small holder farms.

Role of Government

- Strengthening the supply chain infrastructure capacity in strategic areas, so that public and private sector organizations can develop the most relevant post-harvest services for bridging production areas with urban clusters, at domestic and international level.
- Leveraging India's agricultural research and education network to build the technical capacity in horticulture of farmers, traders and other stakeholders, with good post-harvest handling as end-result.
- Developing, consolidating and disseminating information on post-harvest operations and maintenance through various means, including publications and the web-based information network on post-harvest operations.
- Enable access to multiple markets at a national level and to facilitate ease in trading horticulture crops.

Present Status

The 'All India Cold-chain Infrastructure Capacity' (AICIC-2015) study conducted by NCCD-NABCONS, assessed demand and reported the gaps in end-to-end connectivity from farm-to-consumer. The overall status of cold chain infrastructure and requirement is tabulated in Table 1.

The report makes obvious that future focus should be for creation of pack houses, refrigerated transport, ripening chambers instead of standalone large cold storage projects. Cold-chain development expected to disrupt and transform agri-trade and its impact is a continuous process and will require to be studied further.

ICAR network of universities and establishments are adding more resources to horticulture studies and its related knowledge transfer to implementing bodies and farmers.

Government has launched a unified market mechanism in form of the e-NAM, preparing a platform that can facilitate physical movement and trade of all agricultural produce.

Government Schemes and Incentives

The Government is implementing the following schemes which have selective components aimed at strengthening the cold supply chain of horticulture, to increase market connectivity and thereby, reducing food loss:

- Mission for Integrated Development of Horticulture (MIDH) - has a comprehensive set of components and allows investors to build-to-suit and avoid cost and capacity overruns. Promotes fresh whole food supply chain (agricultural produce) such that farmers can link directly with markets and accumulate maximum value.
- Scheme of Ministry of Food Processing Industries – promotes cold-chain across segments including horticulture produce, where destination includes food processing units. Processing units, if attached to the fresh food cold-chain, helps recover some value from non-marketable quality through transformative or additive mechanisms, where the farm produce is converted into product of industry.
- Scheme of Agricultural & Processed Food Products Export Development Authority (APEDA)– promotes cold-chain linked to international markets for agricultural produce, especially, pack-houses for fresh fruits and vegetables.
- Scheme of National Cooperative Development Corporation (NCDC) – provides loans and venture capital to cooperatives in all sectors of agriculture, including horticulture.
- Fiscal and regulatory benefits – exemption from service tax to all activities such as preconditioning (sorting, grading, washing, waxing, packaging, precooling), transportation and storage of agricultural produce (fresh whole food where essential characteristics are not changes); service tax exemption by way of knowledge dissemination of cold-chain; capital investment linked deductions for income tax (150%); zero value added tax on agricultural produce; excise and custom duty exemptions on certain equipment; 100% Foreign Direct Investment (FDI) is allowed under automatic route for setting up warehousing of agriculture products with refrigeration under

State wise distribution of Cold Store capacity (cold-chain) as on 31.03.2016

Sr. no.	Name of the State	upto 2009*		2009-10 to 2015-16						Totals	
				NHB		NHM		MoFPI			
		No.	Capacity (tons)	No.	Capacity (tons)	No.	Capacity (tons)	No.	Capacity (tons)	No.	Capacity (tons)
1	Andaman & Nicobar Islands (UT)	2	210							2	210
2	Andhra Pradesh & Telangana	290	900606	35	214659	96	596021	5	18000	426	1729286
3	Arunachal Pradesh	1	5000							1	5000
4	Assam	24	88068	9	56538			2	8100	35	152706
5	Bihar	246	1147041	28	111821	29	153233	2	4000	305	1416095
6	Chandigarh (UT)	6	12216	1	246					7	12462
7	Chhattisgarh	69	341885	14	68323	13	65349	2	9000	98	484557
8	Delhi	95	126158	2	3699					97	129857
9	Goa	29	7705							29	7705
10	Gujarat	398	1267304	47	152197	237	1131471	10	20000	692	2570973
11	Haryana	244	393121	38	143298	28	111376	8	48000	318	695795
12	Himachal Pradesh	18	19858	7	20504	19	41364	9	24000	53	105726
13	Jammu & Kashmir	19	42869	5	21900	5	29207	4	7000	33	100976
14	Jharkhand	45	170148	8	36757	4	19775	0		57	226680
15	Karnataka	170	407165	8	78844	11	43992	4	18000	193	548001
16	Kerala	193	58105	1	5000			2	15000	196	78105
17	Lakshadweep (UT)	1	15							1	15
18	Madhya Pradesh	197	808052	22	114580	71	320083	4	11000	294	1253715
19	Maharashtra	466	546748	27	98970	55	144142	27	92000	575	881860
20	Manipur	0	0					1	3000	1	3000
21	Meghalaya	3	3200	1	5000					4	8200
22	Mizoram	0	0	1	3471			2	1000	3	4471
23	Nagaland	2	6150							2	6150
24	Orissa	101	291039			65	232100	1		167	523139
25	Pondicherry (UT)	3	85							3	85
26	Punjab	422	1345193	55	176908	166	584902	12	45000	655	2152003
27	Rajasthan	110	324226	25	97401	20	83760	4	16000	159	521387
28	Sikkim	1	2000			1	100	0		2	2100
29	Tamil Nadu	148	238536	16	65047	1	6000	3	7000	168	316583
30	Tripura	11	29450	3	16027			0		14	45477
31	Uttar Pradesh	1589	10118000	495	2923310	157	907998	9	29300	2250	13978608
32	Uttrakhand	15	68499	5	9272	9	19150	15	52000	44	148921
33	West Bengal	463	5682000	14	47812	26	153699	8	57000	511	5940511
TOTALS		5381	244,50,652	867	44,71,586	1013	46,43,722	134	4,84,400	7395	340,50,359

automatic route; 100% FDI with FIPB approval route for trading, including through e-commerce, in respect of food products manufactured or produced in India.

- Reefer Vehicle Call-in-centre for refrigerated transporters to call in and register operational or regulatory bottlenecks in transporting perishables.

Mission for Integrated Development of Horticulture (MIDH)

Under MIDH, financial assistance is provided for developing infrastructure and optimise operations of a wide variety of interlinked activities related to post-harvest management. For the development of post-harvest infrastructure, subsidy @ 35% (for general areas) and 50% (for hilly and scheduled areas) of admissible capital cost of the project is available for both public and private sector enterprises. The admissible components and maximum costs are identified strategically to drive holistic growth for overall integration, including in missing links. The scheme is demand/entrepreneur driven for commercial ventures and the government assistance is back ended and also capped to the bank credit availed. A set of minimum system standards are to be followed to avail the benefits of this scheme. A unique aspect of MIDH is that it incentivises better practices and energy efficiencies in the cold-chain, including modernisation of existing infrastructure assets.

As of 31st March, 2016, a total of 7395 cold storages had been created in the country with a total capacity of 34.05 million MT. Uttar Pradesh has the maximum number of cold stores created on record, followed by Gujarat, Punjab, Maharashtra and West Bengal. Maharashtra has the maximum number of pack houses followed by Karnataka, Chattisgarh, Andhra Pradesh and Odisha. State-wise data of reefer vehicles is not available as there is no separate registration of such trucks in Motor Vehicles Act; it is estimated that less than 10,000 actively refrigerated trucks exist in the country. In case of ripening chambers, these normally are distributed around major urban consumption centres.

The major states which have performed the best with respect to availability of cold chain infrastructures and its utilisation are Gujarat and Maharashtra. North eastern states are lagging behind and therefore, there is a need for marketing and post-harvest infrastructure in these states. PHM development in states is indicated by physical and financial achievement. However, in future there is need to measure success through indicators of the throughput or capacity utilization of the capital assets created. Since PHM infrastructure is built and operated by private sector and support is provided on a demand driven basis, the monitoring and measuring of its capacity utilization will help develop other associated strategies.

As per records, the following five states have performed the best in PHM infrastructure creation and it is proposed that they present their case studies to other state representatives to accomplish their targets.

1. Gujarat
2. Maharashtra
3. Karnataka
4. Andhra Pradesh
5. Uttar Pradesh

The following states which have not performed well in creation of post-harvest infrastructure and are invited to present their concerns or bottlenecks in this aspect.

1. Assam
2. Bihar
3. West Bengal
4. Jharkhand
6. Odisha

A few important and recent case studies are worth mentioning as they demonstrate how PHM helps to expand markets and improves income of farmers. Gujarat successfully steered the use of idle cold store capacity in other states, for their potato in advance of market demand. Punjab spearheaded the opening up of new markets Southern India for a low value item like kinnow by using the cold-chain.

Key Benefits of PHM and Cold-chain

- Creation of PHM infrastructure contributes to Gross Capital Formation in agriculture, adding to overall development. Investment in PHM immediately adds value to the core domain, i.e. cultivation and marketing of produce. Under cold-chain and other post-harvest handling activities, the essential characteristics of produce is not changed by any intermediary; in effect, the value as harvested by farmer is directly linked with consumers. It not only retains farmers as part of the market linked value chain system but empowers them to spread their sales into new geographies.

- Modern PHM brings about transformational changes to the way produce is traded. At the first instance it promotes the consolidation of produce at farm-gate, thereby, also promoting collaboration and cooperation at the back-end, including in cultivation. This effectively drives farmers to achieve a minimal logistical economy of scale, even for small land holdings.
- Modern PHM system empowers decision making at farm-end as produce is sorted by quality for markets. The mere presence of an aggregation and pre-conditioning centre at the back-end, effectively brings market linked logistics to farm-gate.
- Modern PHM management allows opportunity for the farmer to extend his/her market footprint as it expands the saleable range of perishable produce. It also allows opening up of new markets, where traditionally the produce could not reach.
- PHM reduces food loss by aiding market reach and use of technology aided logistics.
- Reduced food loss in the supply chain is a saving for producers. Because it creates a logistics bridge with markets, this in turn positively impacts productivity at farms.
- PHM infrastructure requires a certain economy of scale and therefore, it compels consolidation in production and handling of perishables. This in turn makes farming more collaborative and viable in the long run, both at the commercial and environmental levels.

Way Forward

All PHM development must be with the prime aim to generate improved value realisation for farmers, by enabling them with a choice of markets, across larger geographies and by reducing losses in the supply chain. Capacity building is needed so that PHM development is projectised, optimally across a series of market linking activities. There is need to promote synergy between the multiple sets of activities that end with the physical delivery of produce to markets. Stand-alone creation of infrastructure is not in line with the concept of integrated development of horticulture and should be dissuaded for the majority of crop types. Infrastructure creation should also be preferably linked to available quality of planting material and marketing support. A series of out-reach and awareness programmes about the schemes and advantages in horticulture are to be taken up in all media formats. ■

Source: NCCD

"Indian market will eventually embrace rental TC services"

We have our strong cooling portfolio, with chillers, cooling towers, air-conditioners, air handling units, heat exchangers and accessories, in a range of sizes, for an enviable breadth of applications, informs **Abhijit Pujari, Temperature Control Business Manager – SEA & India, Aggreko** in an interaction with **Cooling India**....

What are the trends in the rental HVACR market?

The rental market in India is highly fragmented and competitive - though it's still at a developing stage, with respect to the US or Europe. With many customers getting awareness on the buy vs rent model, rental concept is picking-up. Also the economic impetus by the government is at a good momentum from 2015 to the present day. Due to the nascent stage, there is clearly a lack of awareness. This is coupled with the capital equipment mentality in India, which restricts the fast development of Temperature Control (TC) services in sectors such as petro-chemical and refining, manufacturing, commercial, construction and events.

So, while these sectors possess a lot of latent demand, it takes a lot of customer education initiatives to reap the full benefit of our TC offerings. The buy vs rent conundrum is still active in India - unlike the developed world where rental options have more acceptance in general. From our own experience of entering the India market in 2009, we could see that the acceptance of TC solutions is growing year on year. The penetration is at a rather low rate given the capital equipment mentality and vast geographical spread out. However, the good news is the market is evolving at a faster pace and the buy vs. rent mindset is changing. We don't expect this to completely change overnight, consistent efforts are required before a long-term shift is acquired.

The fact that Aggreko has successfully gained long term and repeat customers gives us assurances that TC services has a place in the Indian market, but at the same time we are conscious that further penetration is essential at this stage of business.

What reinforces our strategy and TC solutions, are cases like the critical process cooling jobs in refinery and petrochemical setup, the need for augmenting existing cooling during summer, managing capital expenditure constrains or pilot testing. Such experience gives us the confidence that when it comes to TC solutions, a player like Aggreko has customers' trust. As long as this need remains critical in our key sectors we're confident that the Indian market will eventually embrace rental TC services.

Please tell us about Aggreko's Cooling business.

Aggreko has grown from a small local business to a global company providing power and temperature control to businesses and communities around the world.

That's why, we have our strong cooling portfolio, with chillers, cooling towers, air-conditioners, air handling units, heat exchangers and accessories, in a range of sizes, for an enviable breadth of applications – both in process cooling and space cooling. All are owned and operated by us. This wide range of equipment is modular and mobile, which means they're all purpose-built for rental, making for simpler logistics, and quick to install and commission. These solutions are crucial during turnarounds, seasonal spikes in temperature, performance

improvement, pilot testing, maintenance outages, seasonal demands, emergency failures in permanent set-ups, early project commissioning and delay in delivery of permanent cooling equipment. We have provided cooling solutions for over half a century, making us the longest running business in these services. We have strong presence in all core industrial sectors including O&G, mining, manufacturing, petro-chemicals, fertilizers and other bulk chemical manufacturing. However, the Indian market is a little different when compared to other countries, where it's still tended towards outright purchase and will take some time to change this tendency.

Our specialised solutions in both TC and power are suitable for all industrial segments like food and beverage, manufacturing, mining, oil and gas and events etc. Also data centers are a current growth area where TC leads an active role. Our adaptive equipment and experience sets us apart from the competition.

What opportunities do you envisage for your company with government's focus on development of infrastructure projects?

Infrastructure projects is an area where Aggreko has many proven solutions in India and abroad.

In Metro construction, for spot cooling applications in tunnel boring, the customer doesn't have to take multiple sources for cooling. Instead, the chillers and air handling units can be placed at one place and the cooling can be delivered to required spots using flexible ducting. In the new projects coming up, especially, the commercial buildings as part of smart cities, generally, a huge HVAC load is required. So, naturally they have a longer delivery time. Aggreko can support any bridge cooling application till the capital equipment reaches the site.

The industrial sector offers a steady demand for us. This is because Aggreko's cooling solutions boasts proven applications in all phases of the industrial sector value chain. Whether it's pre-production, production, production enhancement or capacity addition, our cooling applications are perfectly suited. Bridge cooling, cooling for pilot testing, process cooling, and summer cooling are just some of the applications we have served in the past. In a nutshell, any boost in the development of infrastructure projects like metro, smart cities or industrial sector is a big boon for Aggreko.

How the Government's 'Make in India' will help the company to expand its footprint in India?

The 'Make in India' initiative is helping to attract the FDI and boost the manufacturing and infrastructure sectors with several positive policies coming in related to mining auction, oil & gas domestic exploration, etc. All of these projects will need cooling or cooling along with power as well. There has been a consistent focus on the program from the government side. The 2018 union budget focuses on the themes of rural development, improvement of the agricultural economy and promoting 'Make in India.'

The support for 'Make in India' is in terms of increase in custom duties of select products. These products have been selected where Indian industry already has or can develop manufacturing capacities in a reasonably short time. Moreover, the recent Economic Survey reveals that 'Make in India 2.0' will accord renewed focus on ten champion sectors, including capital goods, auto, defense, pharma and renewable energy to push growth in manufacturing and generate job opportunities. The government has identified these sectors that have the potential to become global champions and drive double-digit growth in manufacturing. If you look at these sectors, many of them coincide with the focused sectors of Aggreko's cooling business. As we support many industries in seasonal spikes in temperature, performance improvement, pilot testing and early project commissioning, maintenance outages and emergency failures in permanent set-ups and in the delay in delivery of permanent cooling equipment, we will benefit from the 'Make-in-India' initiative in general. As with footprints, our fleets are strategically located in Manesar, Chennai, Pune and Vizag. This arrangement helps us to cater to the whole of India in a nimble manner. We have reached places like Assam in the North East to Balmer in the west; Tuticorin in the south to Jammu in the North.

What are the growth drivers of your business?

When it comes to macro-economic growth drivers, the year 2018 and Aggreko have been placed very well in the market. Demonetisation has stabilised in the market, GST has started showing the impact and the 'Make in India' initiative is running on the right tracks.

Sectors such as mining and O&G are expected to do well in the short term as there is focus to increase the domestic exploration and production. Good traction is expected in defence and shipyards as well. Specific to the process cooling opportunities in India, the industry is likely to grow at the back drop of investments expected in the process industries on account of high domestic consumption. Aggreko plays a pivotal role where power application and temperature control bridges a gap for many sectors, including manufacturing, oil & gas, mining and shipyards to name a few. In all of these sectors there are also emergency situations, caused by sudden equipment breakdown or natural and environmental disasters where our short term power and cooling solutions can help. Our global presence and experience has helped support customers in all sectors and across the globe, including India. Our major sectors, however, are quite balanced between manufacturing, events, oil & gas, mining and shipping.

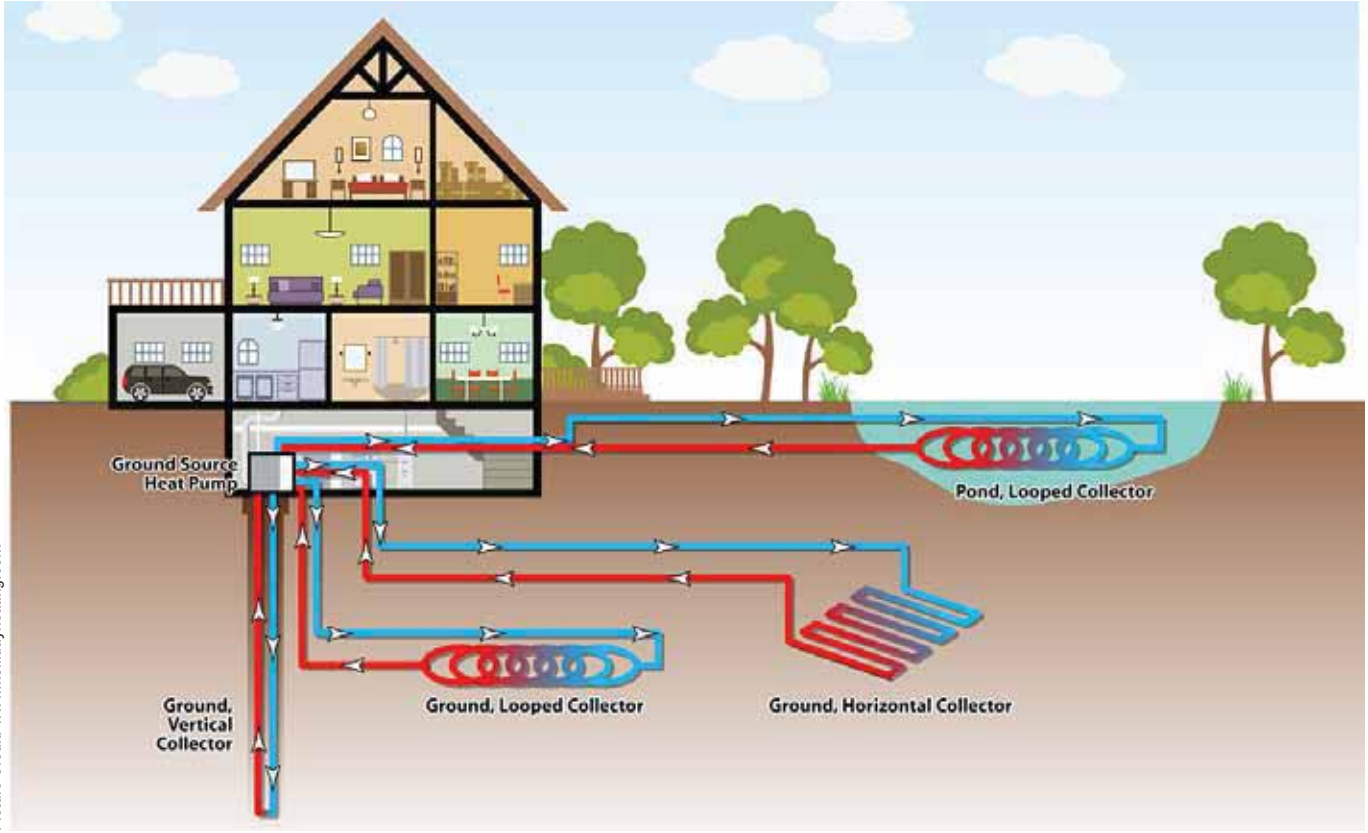
What is your outlook for HVACR industry?

The Indian HVACR industry is about 3 billion USD currently, based on our internal research. Growing infrastructure-based developments, technological advancements and increasing tourism are expected to positively influence Indian HVAC market over the next five years. Moreover, extreme climatic conditions, rising disposable income, growing construction activities in both commercial and residential sectors coupled with various government initiatives aimed at improving energy efficiency, are some of the other major factors expected to boost the India HVAC market for the short-term. ■

Geothermal Heat Pump Prospect for Sustainable Development

(Part 1)

This study highlights the energy problem and the possible saving that can be achieved through the use of ground sources energy. Also, this study clarifies the background of the study, highlights the potential energy saving that could be achieved through use of ground energy source and describes the objectives, approach and scope of the thesis.



Picture Credit: www.hollidayheating.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 11-13oC several metres below the surface all the year around. Among many other alternative energy resources and new potential technologies, the ground source heat pumps (GSHPs) are receiving increasing interest because of their potential to decrease primary energy consumption and thus reduce emissions of greenhouse gases.

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

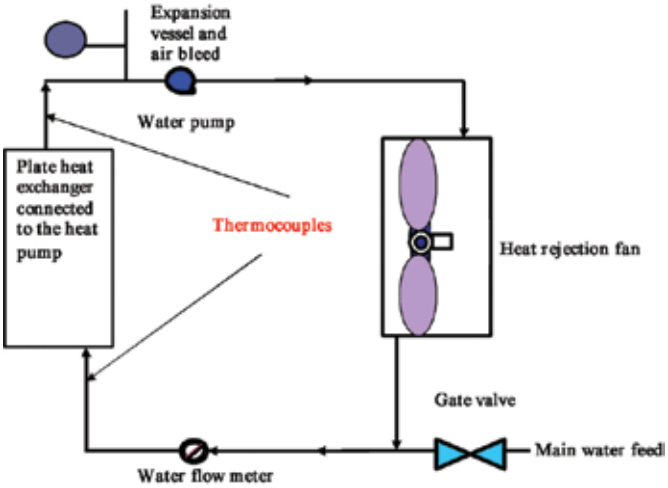


Figure 1: Sketch of installing a heat pump

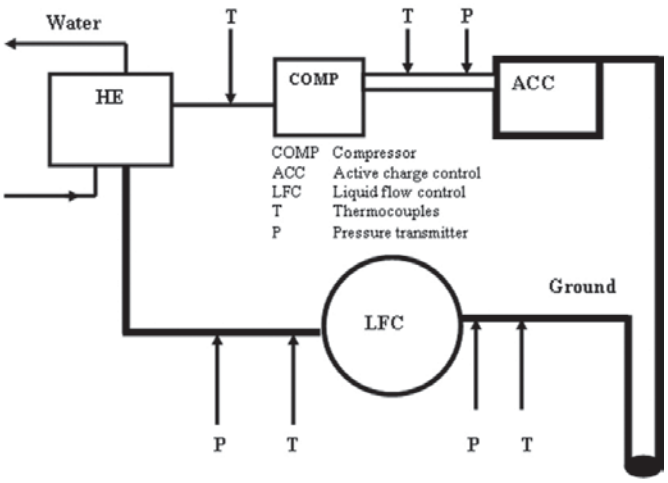


Figure 2: Ground loops connections to heat pump & heat exchanger

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

The GSHPs in some homes also provide:

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

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

An air-source heat pump is convenient to use and so it is a better method for electric heating. The ambient temperature in winter is comparatively high in most regions, so heat pumps with high efficiency can satisfy their heating requirement. On the other hand, a conventional heat pump is unable to meet the heating requirement in severely cold regions anyway, because its heating capacity decreases rapidly when ambient temperature is below -10°C. According to the weather data in cold regions, the air-source heat pump for heating applications must operate for long times with high efficiency and reliability when ambient temperature is as low as -15°C. Hence, a great deal of research and development has been conducted to enable heat pumps to operate steadily with high efficiency and reliability in low temperature environments (Bowman, et al., 2001). For example, the burner of a room air conditioner, which uses kerosene, was developed to improve the performance in low outside temperature (Li, et al., 2004). Similarly, the packaged heat pump with variable frequency scroll compressor was developed to achieve high temperature air supply and high capacity even under the low ambient temperature of –10 to –20°C. Such heat pump systems can be conveniently used for heating in cold regions. However, the importance of targeting the low capacity range is clear if one has in mind that the air conditioning units below 10 kW cooling account for more than 90% of the total number of units installed in the EU.

Methods and Laboratory Measurements

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

Main Experimental Test Rig

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

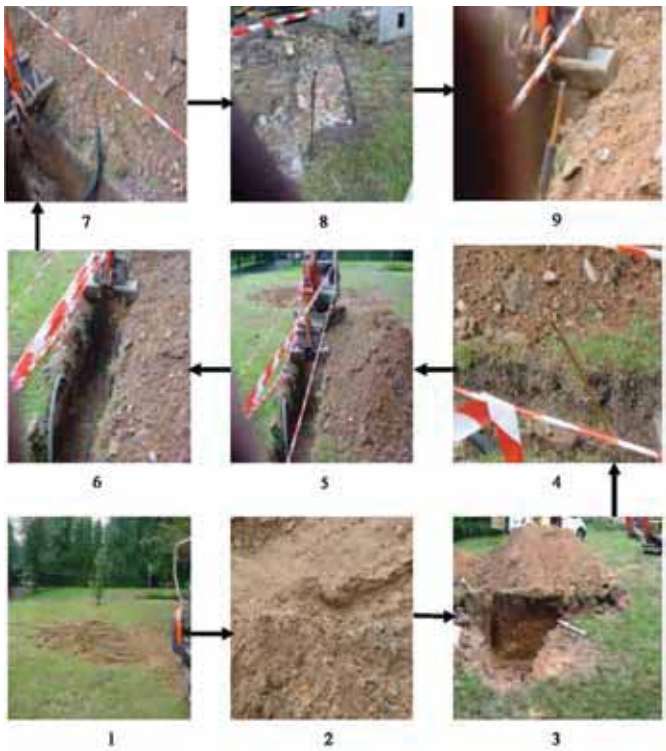


Figure 3: Drilling (1-2) digging of the pit (3), connection of the manifolds (4), grouting, preparation of the coils (5-6) and the source loop, which consists of two earth loops: one for vapour and one for liquid (7-9)

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

Direct Expansion Heat Pump Installation

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

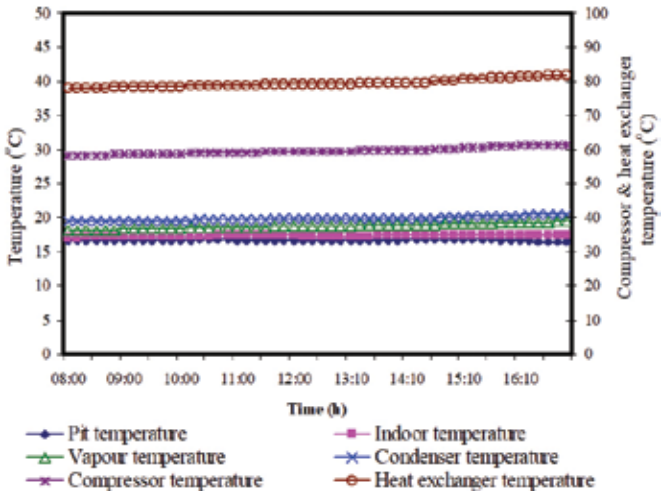


Figure 5: Variation of temperatures per day for the DX system

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

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

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

The direct expansion (DX) GSHP installed for this study was designed taking into account the local meteorological and geological conditions. The site was at the School of the Built

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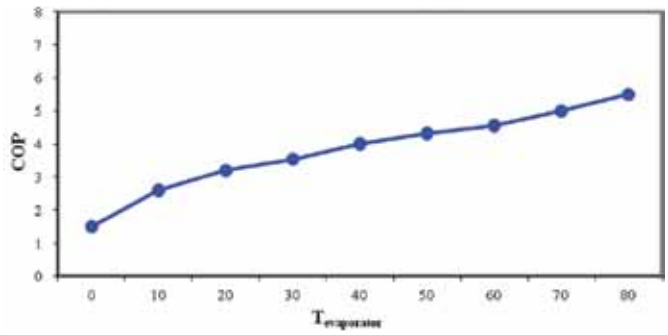

Figure 6: Heat pump performance vs evaporation temperature

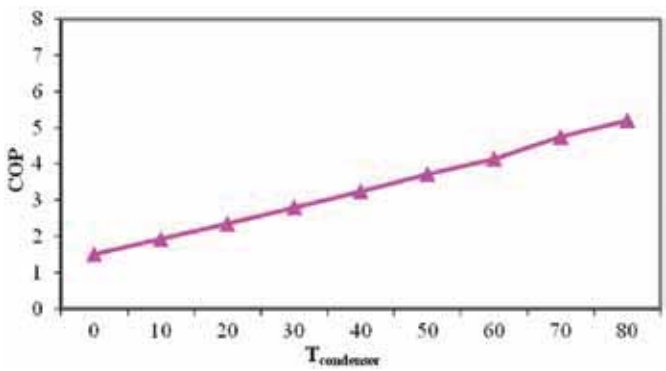

Figure 7: Heat pump performance vs condensation temperature

Environment, University of Nottingham, where the demonstration and performance monitoring efforts were undertaken Figures (3-4). The heat pump has been fitted and monitored for a one-year period. The study involved the development of a design and simulation tool for modelling the performance of the cooling system, which acts as a supplemental heat rejecting system using a closed-loop GSHP system. With the help of the Jackson Refrigeration (Refrigeration and Air Conditioning engineers) the following tasks were carried out:

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

Water Supply System

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

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

In these circumstances, the study estimated the heat properties of the soil in the city of Nottingham and measured the thermal conductivity for the soil at some points in this city, aimed at identifying applicable areas for ground source heat pump system.

Design and Installation

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

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

Heat Pump Performance

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

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

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

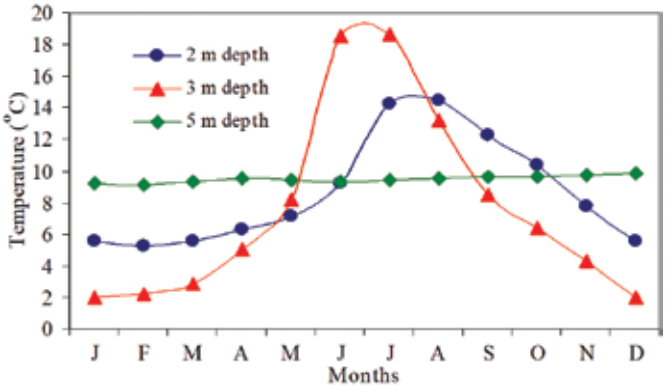

Figure 8: Seasonal temperature variations

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

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

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

Coefficient of Performance (COP)

Heat pump technology can be used for heating only, or for cooling only, or be 'reversible' and used for heating and cooling depending on the demand. Reversible heat pumps generally have lower COPs than heating only heat pumps. They will, therefore, result in higher running costs and emissions. Several tools are available to measure heat pump performance. The heat delivered by the heat pump is theoretically the sum of the heat extracted from the heat source and the energy needed to deliver the cycle. Figure 5 shows the variations of temperature with the system operation hours. Several tools are available to measure heat pump performance. The heat delivered by the heat pump is theoretically the sum of the heat extracted from the heat source and the energy needed to derive the cycle. For electrically driven heat pumps the steady state performance at a given set of temperatures is referred to as the coefficient pf performance (COP). It is defined as the ration of the heat delivered by the heat pump and the electricity supplied to the compressor:

COP = [heat output (kW_{th})] / [electricity input (kW_{el})] (1)

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

COP = [condensing temperature (°C)] / [temperature lift (°C)] (2)

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

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

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

[Net amount of energy added to system] =
[Net increase of stored energy in system] (3)

or

[Energy in] – [Energy out] = [Increased of stored energy in

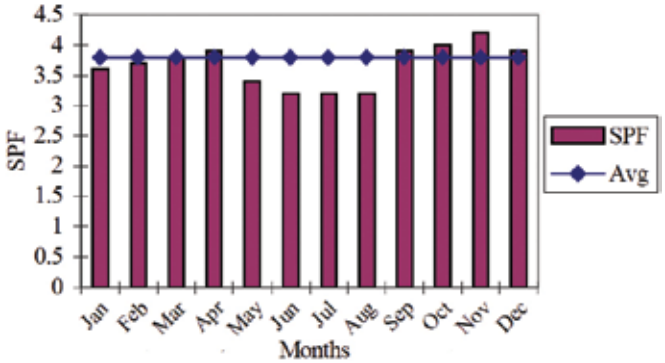

Figure 9: Seasonal performance for individual months and average for 2008

system] (4)

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

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

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

Where:

I is the irreversibility rate, kW/K.

T_o is the absolute ambient temperature, K

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

COP = [Useful refrigeration effect]/
[Net energy supplied from external sources] (6)

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

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

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

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

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

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

Seasonal Performance Factor (SPF)

There are two primary factors to describe the efficiency of heat pumps. First, the coefficient pf performance (COP) is determined in the test stand with standard conditions for a certain operating point and/or for a number of typical operating points. Second, the seasonal performance factor (SPF), describes the efficiency of the heat pump system under real conditions during a certain period, for example for one year. The SPFs in this case are the ratio of the heat energy produced by the heat pump and the back-up heater and the corresponding energy required of the heat pump. The SPF for individual months and an average value for the year 2008 for the DX GSHP are shown in Figure 9. The assessment of the 2008 measurement data for the GSHP in the buildings providing both heating and cooling reveals a seasonal performance factor (SPF) of 3.8. The SPF of the individual system was in the range of 3.0-4.6.

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

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

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

Comparison of Numerical Simulation & Experiments

The GSHPs are generally more expensive to develop, however, they have very low operating costs, therefore, it is necessary to have an idea of the energy use and demand of these equipment. The performances are normally rated at a single fluid temperature (0°C) for heating COP and a second for cooling EER (25°C). These ratings reflect temperatures for an assumed location and

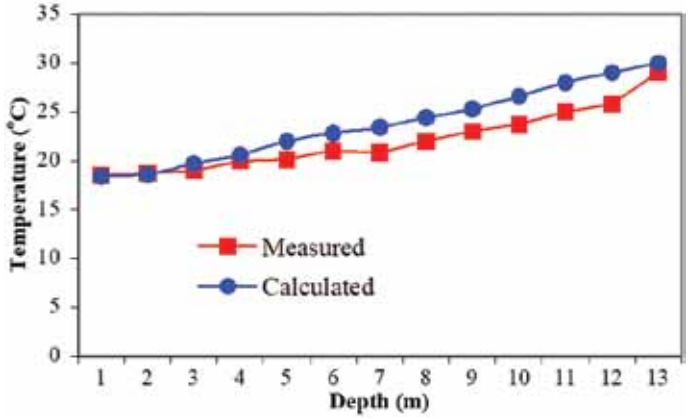

Figure 10: Comparison of calculations and experiments for saturated soil with groundwater flow (SSG)

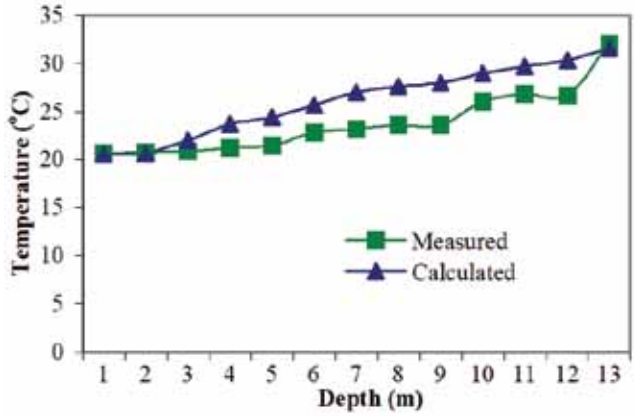

Figure 11: Comparison of calculations and experiments for saturated soil without groundwater flow (SS).

ground heat exchanger type, and are not ideal indicators of energy use. This problem is compounded by the nature of ratings for conventional equipment. The complexity and many assumptions used in the procedures to calculate the seasonal efficiency for air-conditioners, furnaces, and heat pumps (SEER, AFUE, and HSPF) make it difficult to compare energy use with equipment rated under different standards. The accuracy of the results is highly uncertain, even when corrected for regional weather patterns. These values are not indicators for demand since they are seasonal averages and performance at severe conditions is not heavily weighted.

The American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) recommends a weather driven energy calculation, like the bin method, in preference to single measure methods like seasonal energy efficiency ratio (SEER), seasonal performance factor (SPF), energy efficiency rating (EER), coefficient of performance (COP annual fuel utilisation efficiency rating (AFUE), and heating season performance factor (HSPF).

The bin method permits the energy use to be calculated based on local weather data and equipment performance over a wide range of temperatures. Both solid and liquid parts co-existed in one control volume of non-isothermal groundwater flow. It was, therefore, necessary to integrate the two parts into one energy equation. Accordingly, the governing equation describing non-isothermal groundwater flow in a saturated porous medium was as follows:

$$T\,(\Delta v) + (\delta T/\delta t)\,\sigma = \alpha_t\,\Delta^2 T + qt/\,(\rho C_p)f \qquad (10)$$

$$(\rho Cp)t = \psi\,(\rho Cp)f + (1-\psi)\,(\rho C_p)s \qquad (11)$$

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

$$WH\,(\sigma d)\,\delta f_s/\delta t_s = q_s \qquad (12)$$

$$(\delta T/\delta t)\,\sigma + U_x\,\delta T_f/\delta x = \alpha t\,\Delta^2 T + qt/\,(\rho Cp)f \qquad (13)$$

Where:

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

W is the water content in soil (%); T is the temperature (°C).

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

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

f_s is the solid phase ratio.

s is the soil; f is the groundwater.

Ψ is the porosity.

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

δ is volumetric specific heat ratio.

ρ is the density (kg m^{-3}).

The experiments and calculations are conducted for unsaturated soil without groundwater flow (US), saturated soil without groundwater flow (SS) and saturated soil with groundwater flow (SSG) under same conditions and their results are compared with each other in Figures 10-13. The temperature in vertical

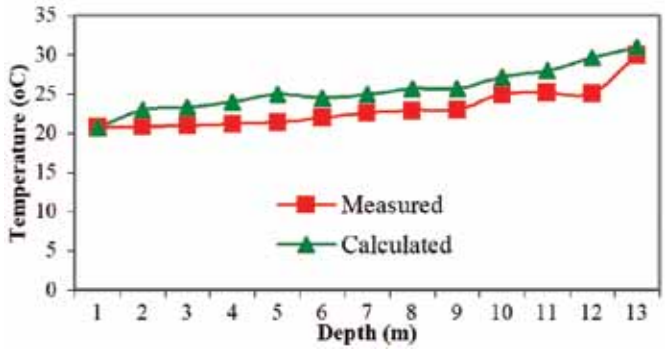

Figure 12: Comparison of calculations and experiments for unsaturated soil without groundwater flow (US).

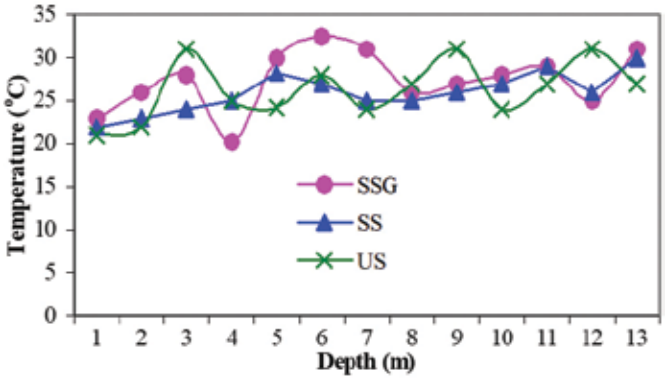

Figure 13: Comparison of experiments for saturated soil with groundwater flow (SSG), saturated soil without groundwater flow (SS) and unsaturated soil without groundwater flow (US).

boreholes used, as heat source for GSHPs will slowly drop with time, so more energy is extracted. This can be mitigated either by a deeper borehole (in a new installation) or a system to replenish the energy extracted from the hole (in both new and existing installations). Raising the brine temperature from -5°C to 0°C may improve the COP by 10-50% depending on the type of heat pump.

Performance Enhancement of GSHP

The heat transfer between the GSHP and its surrounding soil is affected by a number of factors such as working fluid properties (e.g., 20% glycol) and its flow conditions, soil thermal properties, soil moisture content and groundwater velocity and properties, etc. The GSHP has a great potential to be one of the main energy sources in the future as it can be tapped in a number of different ways and can be used to produce hot water as well as electricity. It has a large spatial distribution with almost all countries having at least low enthalpy resources available (less than 125°C) and many countries around the world in both developing and developed countries are already harnessing it. It is a resource that has always been there and does not rely on specific factors such as the wind to be blowing or the sun to be shining, as is the case with other forms of renewable energies. The GSHP is inherently clean and environmentally sustainable and will soon become more economical than combustion (fossil fuel) plants as regulations on plant emission levels are tightened and expensive abatement measures such as carbon capture and storage become compulsory. This study urges the need for the GSHP to be considered much more strongly than it currently is in environmental policies as it has been overlooked as a main alternative to fossil fuels and other forms of renewable energies.

Geothermal power utilises the heat energy naturally produced within the earth. Its wide abundance and renewable nature make it an attractive alternative energy source to fossil fuels. The environmental impact of geothermal power plants is negligible in comparison to combustion plants and it is progressively becoming more financially viable as emission regulations are tightened. The technology is increasingly being utilised by countries all over the world, as there are many different ways in which geothermal energy can be harnessed. Geothermal power is very competitive with other sources of energy when it comes to energy costs. Table 2 shows the globally averaged energy costs in 2014 for different energy sources and shows what the potential future energy costs for different sources will be. As shown in table 2, geothermal is already generally more financially viable and cost-effective globally than other forms of renewable power, being on par with hydro-electricity (however, it is important to note that costs will vary between countries).

Table 2: Comparison of energy costs between different energy sources

Energy source	Energy costs (US¢/kWh)	Potential future energy costs (US¢/kWh)
Hydro	2-10	2-8
Biomass	5-15	4-10
Geothermal	2-10	1-8
Wind	5-13	3-10
Solar	25-125	5-25
Tidal	12-18	4-10
Coal	4	0.4

Over its first year of operation, the ground source heat pump system has provided 91.7% of the total heating requirement of the room and 55.3% of the domestic water-heating requirement, although only sized to meet half the design-heating load. The heat pump has operated reliably and its performance appears to be at least as good as its specification. The system has a measured annual performance factor of 3.16. The system is quiet and unobtrusive and achieved comfort levels. The heat pump does not reduce the useful space in the laboratory, and there are no visible signs of the installation externally (no flue, vents, etc.). The performance of the heat pump system could also be improved by eliminating unnecessary running of the integral distribution pump. It is estimated that reducing the running time of this pump, which currently runs virtually continuously, would increase the overall performance factor to 3.43. This would improve both the economical and the environmental performance of the system. More generally, there is still potential for improvement in the performance of heat pumps, and seasonal efficiencies for ground source heat pumps of 4.0 are already being achieved. It is also likely that the unit costs will fall as production volumes increase.

Energy Efficiency Ratio (EER) is a ratio calculated by dividing the cooling capacity in watts per hour by the power input in watts at any given set of rating conditions. Coefficient of performance

(COP) is a ratio calculated for both the cooling (C) and heating (H) capacities by dividing the capacity expressed in watts by the power input in watts (excluding any supplementary heat). Table 3 summarises COP for different loops. Tables 4-5 present energy efficiency ratios for cooling and heating purposes.

Ground storage systems can be classified in many different ways. One of the most important classifications is in accordance to the temperature of the storage. The ground storage systems are classified as follows:

- The GSHPs, without artificial charging the soil - temperature about 10°C.
- Low temperature ground storage - temperature < 50°C.
- High temperature ground storage - temperature > 50°C.

Table 3: COPs for different loops

Type of system	COPC	COPH
Opened loops	4.75 at 15°C	3.6 at 10°C
Closed loops	3.93 at 25°C	3.1 at 0°C
Internal loops	3.52 at 30°C	4.2 at 20°C

Table 4: Energy efficiency ratios for cooling and heating applications

Application	Type of system	Minimum EER	Minimum COP
Cooling	Opened loops (10°C)	13.0	-
Heating	Closed loops (25°C)	11.5	-
	Opened loops (10°C)	-	3.1
	Closed loops (0°C)	-	2.8

Table 5: Direct expansion closed loop ground or water source heat pumps

Application	Type of system	Minimum EER	Minimum COP
Cooling	Opened loops (10°C)	11.0	3.2
Heating	Closed loops (25°C)	10.5	3.1
	Opened loops (10°C)	-	3.0
	Closed loops (0°C)	-	2.5

Table 6 shows COP and EER for different applications. Conserving natural resources will benefit everyone now and into the future. For homebuilders, green building means the resource-efficient design, construction, and operation of homes. It represents an approach to both building and marketing homes that highlights environmental quality.

Table 6: Key energy star criteria for ground-source heat pumps

Product Type	Minimum EER	Minimum COP	Water Heating (WH)
Closed-loop	14.1	3.3	Yes
With integrated WH	14.1	3.3	N/A
Open-loop	16.2	3.6	Yes
With integrated WH	16.2	3.6	N/A
DX	15.0	3.5	Yes
With integrated WH	15.0	3.5	N/A

Conclusion

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

The performance of the heat pump system could also be improved by eliminating unnecessary running of the integral distribution pump. It is estimated that reducing the running time of the pump, which currently runs virtually continuously, would increase the overall performance factor to 3.43. This would improve both the economic and the environmental performance of the system. More generally, there is still potential for improvement in the performance of heat pumps, and seasonal efficiencies for ground source heat pumps of 4.0 are being achieved. It is also likely that the unit costs will fall as production volumes increase. By comparison, there is little scope to further improve the efficiency of gas or oil-fired boilers. ■

Abdeen Mustafa Omer
Energy Research Institute (ERI),
Nottingham, United Kingdom

CO_2 Refrigeration proves to be Healthy Option...

Project Objective

CO_2 refrigeration is now being accepted as a practical and proven option for many varied applications and is fast becoming a mainstream cooling solution within the healthcare sector.

Green Cooling has seen the specification levels of CO_2 cooling and heating systems increase dramatically in 2015, applications range from food service to manufacturing and commercial offices through to the healthcare sector. A CO_2 refrigeration installation has recently been completed by Green Cooling at one of the UK's largest University Hospitals. The hospital is a major regional facility, focused around delivering the highest level of efficiency and quality within all of its operational areas. For this reason, a Green Cooling-Enex CO_2 refrigeration system was specified in a recent construction project completed within one of the hospitals major new departments.

Hospitals across the UK are seeing a huge number of construction projects either underway or planned, with refrigeration playing a major part in many of these projects the attention is now moving towards applying refrigeration systems that provide both efficiency and sustainability.

Green Cooling-Enex CO_2 refrigeration systems are able to deliver significant energy savings whilst providing the obvious environmental & sustainable benefits that can be achieved by a natural refrigerant, due to these factors CO_2 systems are being specified and applied across an increasing number of healthcare projects. The design team at Green Cooling have over 20 years' experience with regard to the design, specification and installation of cooling systems within a variety of hospital applications.

Therefore, having designed the first CO_2 hospital cooling project in 2009, the team at Green Cooling are well placed to continue developing their reputation as a leader in delivering efficient and sustainable refrigeration systems, by providing the latest Enex CO_2 equipment.

Garry Broadbent of Green Cooling commented, "Our early 2015 appointment as the exclusive UK distribution and service partner for the CO_2 manufacturer Enex now enables us to provide a complete package", continuing," we provide a full service which includes system design with manufacturer application support, through to supply & installation."

This appears to put Green Cooling in a strong position within this fast-growing CO_2 refrigeration sector. Because of the continuing resurgence of CO_2 as a practical refrigerant, the sector needs equipment providers that provide a high level of application and technical specification support.

For this reason, the company have been contracted to supply CO_2 refrigeration systems on two hospitals so far in 2015 with more in the planning stage. This appears to demonstrate that the diligent approach to promoting the most efficient CO_2 application methods practised by Green Cooling is being very well received within the demanding healthcare sector.

Project equipment & specification:

- 1 x 45kW Enex CO_2 centralised refrigeration system, multi-compressor configuration operating at -10°C
- 1 x Green Optimisation Web based Management & Maintenance
- System (G0 Plus system)
- 1 x Packaged Remote Dry Cooler/Condenser Unit
- All inter connecting pipe work and ancillaries
- Design, specification, application and installation/
- commissioning support

Project Outcome

The CO_2 system installed provides critical cooling to an important area of the hospital; multiple points of cooling are supplied by a CO_2 centralised system, which comprises of a multiple inverter driven compressor configuration in order to provide efficiency & contingency.

A complete design and specification support service was provided to the main contractor on the project which enabled a system to be provided which satisfied all aspects of the project brief in terms of the performance and sustainability of the installation as a whole. Major hospitals demand high standards at every stage of a project from design to completion, as such the Project Delivery Team at Green Cooling understand these requirements and are able to run a controlled installation with a flexible approach geared towards efficient delivery.

Being the UK distributor for the manufacturer Enex, the Green Cooling team are able to deliver the high level of support that would be expected from one of Europe's leading CO_2 manufacturers along with an experienced and knowledgeable UK application team.

This has resulted in a CO_2 hospital cooling system being installed that meets all of the project requirements, was delivered on schedule and provides the application with efficient & sustainable operation. ■

HORTICULTURE CROPS CATEGORY WISE 2017-18 (1st Adv. Est.)

Area in '000 Ha, Production in '000 MT

Sl. No.	STATES/UTs	FRUITS		VEGETABLES		PLANTATION		AROMATICS & MEDICINAL		FLOWERS		
		A	P	A	P	A	P	A	P	A	P	
											LOOSE	CUT
1	Andhra Pradesh	639.56	13912.66	223.58	8503.87	319.43	1063.53	7.74	15.53	22.20	396.20	0.00
2	Arunachal Pradesh	49.15	125.34	1.77	14.57	0.07	0.10	0.46	0.99	0.02	0.01	0.07
3	Assam	163.99	2433.95	320.70	4033.30	95.50	190.64	4.49	0.17	5.17	34.55	57.75
4	Bihar	307.79	4234.62	841.91	14520.97	14.90	97.30	4.50	0.60	0.66	7.96	0.00
5	Chhatisgarh	228.730	2514.493	502.084	7000.822	15.000	16.830	8.728	62.303	13.161	51.598	79.913
6	Gujarat	415.34	9026.79	649.62	13292.86	31.66	238.67	0.00	0.00	20.64	195.98	0.00
7	Haryana	67.00	1050.00	465.00	7905.00	0.00	0.00	0.17	1.17	6.58	69.00	10.12
8	Himachal Pradesh	229.20	596.29	87.986	1770.286	0.00	0.00	1.12	0.91	0.71	17.95	9.64
9	Jammu & Kashmir	338.82	2241.16	59.24	1424.52	0.00	0.00	3.83	0.01	49.58	29.70	0.39
10	Jharkhand	99.96	1034.81	283.22	3399.88	14.83	6.13	0.00	0.00	0.39	11.08	9.67
11	Karnataka	439.21	7559.08	507.70	8547.30	883.24	5198.81	2.42	16.77	52.37	238.73	62.31
12	Kerala	252.16	2493.90	138.70	2010.78	975.15	5354.85	0.01	0.00	19.15	0.03	0.90
13	Madhya Pradesh	354.87	7004.95	929.76	18208.79	2.29	3.52	73.63	507.09	16.10	128.16	97.91
14	Maharashtra	695.085	10879.882	572.134	9043.984	207.325	370.318	0.208	0.088	5.485	29.08	56.99
15	Manipur	54.931	523.609	58.208	359.298	0.90	0.32	0.00	0.00	0.24	0.06	0.30
16	Meghalaya	35.50	443.02	49.73	522.55	25.52	33.25	0.00	0.00	0.01	0.00	0.35
17	Mizoram	62.89	342.04	36.98	179.86	11.90	7.38	0.77	0.82	0.20	0.46	0.00
18	Nagaland	39.32	380.30	47.06	561.57	2.05	9.34	0.10	0.49	0.06	0.02	6.18
19	Odisha	341.30	2433.61	639.84	8768.77	234.23	334.20	1.92	0.61	0.64	2.18	5.06
20	Punjab	90.61	1908.46	244.30	4917.68	0.00	0.00	13.09	2.66	2.07	12.96	0.00
21	Rajasthan	57.39	1008.08	181.37	1935.76	0.00	0.00	380.00	260.00	2.71	4.02	0.00
22	Sikkim	18.33	24.01	25.54	190.72	0.00	0.00	0.00	0.00	0.24	16.50	0.09
23	Tamil Nadu	290.08	5158.35	211.23	5656.99	643.23	4659.30	11.98	152.83	30.89	426.66	15.46
24	Telangana	164.83	1765.90	85.96	1519.30	0.26	1.31	0.02	0.10	3.07	10.06	10.47
25	Tripura	58.18	594.70	46.57	802.37	16.15	33.68	0.00	0.00	0.00	0.00	0.00
26	Uttar Pradesh	475.82	10521.77	1438.09	28226.19	0.00	0.00	135.04	13.53	21.06	46.00	64.64
27	Uttarakhand	179.10	669.48	92.15	954.74	0.00	0.00	0.00	0.00	1.40	2.07	12.10
28	West Bengal	260.69	3848.97	1393.58	25892.08	52.54	294.13	0.00	0.00	26.49	74.63	203.42
29	Others	18.65	153.67	38.42	519.34	118.10	139.09	0.00	0.00	6.56	0.28	0.52
	All India Total	6428.48	94883.86	10172.41	180684.15	3664.26	18052.70	650.21	1036.67	307.87	1805.92	704.23

Source: National Horticulture Board

New Extech Laser Distance Meters

Extech Instruments, a world leader in test and measurement tools, announced the launch of the DT-M series of pro-grade laser distance meters. The three new Extech meters make it easy to measure distances, compute area and volume, measure angles, and stake out distances between objects. Users can quickly take measurements with one-button, point-and-shoot convenience, saving time and dollars resulting from estimating errors.

The DT-M series includes three meters with distance capabilities for a range of jobs: DT40M: 131ft, 40m, DT60M: 196ft, 60m and DT100M: 330ft, 100m. The DT-M meters' bright laser and large, backlit, 4-line display make it easy to measure targets with 0.08" (2mm) accuracy. With their compact, rugged double-molded design and wrist strap, users can take these distance meters anywhere. The pocket-sized meters are ideal for one-hand operation and measurements can be taken from the front or rear edge. A built-in bubble level ensures the accuracy of horizontal measurements.

Useful functions include min/max readings; indirect height measurements using Pythagorean calculations (standard height, height in two segments, and partial height) from two or three other measurements; 20 successive reading memory; easy addition and subtraction of multiple readings; and auto power off to conserve battery life. With the stake-out function, users can mark recurring distance intervals, such as the distance between studs for wall framing, between fence posts, lampposts on a path, etc. The meter's beeping cues and numerical readings indicate if a distance is greater or less than the desired interval.

The laser distance meters are designed for construction workers, contractors, realtors, home appraisers, renovation and remodeling professionals, electrical and HVAC estimators and others who routinely need quick measurements at a job site. The DT-M series is backed by Extech's one-year warranty and comes with two AAA batteries.

Email: flirindia@flir.com.hk

Elanpro Introduces New Edgy Counter Top Chiller

Reiterating its commitment to bring innovative display options for the retail market, Elanpro, India's leading commercial refrigeration company, recently added SC 66 - Counter Top Chiller, to its product portfolio. With a small footprint and portable, lightweight design, Elanpro Counter Top Chiller is a cost-effective solution designed to meet the impressive display needs.

Elanpro Counter Top Chiller is available in 66 litres with top sliding glass door. The user-friendly product is compact in size and can be cleaned easily for maintaining high standards of hygiene. It features microprocessor-based control for precise temperature and heated along with low emissibility glass for zero condensation and perfect display. The chiller has molded plastic door frame, special quality glasses for clear display, high performing cooling system and beautiful aesthetics along with precise temperature controls. It has high performing unit designed to work at high temperature.

Elanpro has launched this compact design for companies aiming the impulse buying. The glass merchandise display helps showcase bottled products and promote sales of featured beverages. It can be used for displaying products in small quantities or for a new launch. Elanpro counter top chiller is ideal for super markets, restaurants, delis, bakeries and convenience stores looking to expand their offerings display, while saving valuable counter space.

Elanpro Counter Top Chiller provides reliable performance, stunning presentation of products and energy efficiency. Priced at Rs. 26,000, the product is now available at Elanpro dealer stores.

Website: www.elanpro.net

Climaveneta's Air Cooled Chillers

Outdoor unit for the production of chilled water with fixed speed and variable speed (Inverter Driven), scroll compressors, optimized for R410A in a single-circuit configuration, axial-flow fans, micro-channel full-aluminum air coils and electronic expansion valve as standard equipment. Flexible and reliable unit; it easily adapts itself to different thermal load conditions thanks to the precise temperature control together with the use of inverter technology. The high performance's level, both full and partial load, is achieved thanks to the accurate unit's design and to the use of fixed speed motor together with variable speed (inverter) motor.

Features

High Efficiency

Unit with high efficiency and reduced energy consumption, thanks to the inverter technology, contributing to lower operating costs and therefore, achieving a quick return on investment.

ErP Ready

The highest level of efficiency at part load, thanks to the inverter technology, can meet and exceed the minimum seasonal efficiency for cooling, SEER, according with the eco-sustainable design requirements for all products using energy.

Variable Primary Flow

Energy saving due to variable pump speed management based on load demand and the variable flow assures the functioning of the units also with critical working conditions.

Integrated Hydronic Module

The built-in hydronic module already contains the main water circuit components; it is available as option with single or twin in-line pump, for achieving low or high head, fixed or variable speed and buffer tank.

Electronic Expansion Valve Supplied

The use of the electronic expansion valve generates considerable benefits, especially in cases of variable demand and at different working conditions.

Website: www.climaveneta.com

Mitashi's Xtreme Heavy Duty ACs

Mitashi, India's leading premium homegrown consumer electronics brands, has added 7 new Xtreme Heavy Duty range to its ACs and they've got everything you could ask for!

This summer, with the launch of 30 new models, which includes 7 Xtreme Heavy Duty ACs, Mitashi offers patrons a wide choice! These newly launched Xtreme Heavy Duty (XHD) ACs come in a variety of sizes, viz. 1 ton (MiSAC102vXHD, MiSAC103vXHD, MiSAC103INvXHD), 1.5 ton (MiSAC152vXHD, MiSAC153vXHD, MiSAC153INvXHD) and 2 tons (MiSAC202vXHD), to cater to every kind of use and requirement.

Top concerns with AC usage are cooling in the sweltering heat when temperatures regularly go as high as 48 degrees regularly and high electricity bills that come along with it. Not to mention the often-high costs of maintenance.

- 100% Copper Pipes: Helps with greater cooling and thereby, helps conserve electricity, save on bills.
- Gold Fins: Help in protecting AC from humidity and moisture
- 4-Way Swing: Aids in cover larger areas for cooling as the vents move up, down, right and left.
- Inner Grooved Tubes: Grooved Tubes give more exchange area and help save on electricity by facilitating smoother or faster heat transfer
- Highest CFM: Wider Airflow with a longer range cools the room quickly
- Heavy Duty Outdoor Unit: All components are made from top quality materials, ensuring you get great cooling even with heavy usage
- Auto Clean Function: Eliminates moisture and prevents the growth of harmful microorganisms. Which means you breathe cleaner, healthier air
- 5 Years Warranty: Which includes a 5-year product & compressor warranty, rarely offered by any other player. Use it worry-free!

All Mitashi XTREME Heavy Duty ACs come with modern features such as super silent operation, wide and long airflow, Hidden LED display, remote control with display, low power consumption, auto restart, wide voltage operation range, sleep timer, anti-bacterial filter, turbo cooling and energy saver. Mitashi also offers 2 free PMS services within the first year.

Website: www.mitashi.com

Forthcoming Events At A Glance

India Cold Chain Show - Regional

Venue: Pragati Maidan, New Delhi
Date: 21st to 23rd June 2018
Website: www.indiacoldchainshow.com

Indoor Air 2018

Venue: The Pennsylvania Convention Center, Philadelphia
Date: 22nd to 27th July 2018
Website: http://mms.isiaq.org

DairyTech India 2018

Venue: Bangalore International Exhibition Centre (BIEC)
Date: 31st to 2nd September 2018
Website: www.dairytechindia.in

Chillventa

Venue: Nuremberg, Germany
Date: 16th to 18th October 2018
Website: www.chillventa.de

Honeywell Appoints Nefkens as President & CEO of Homes Business

Honeywell announced that it has appointed Michael G Nefkens – an experienced technology executive with a strong customer focus and proven record of delivering innovative solutions and shareholder value – as President and CEO of its Homes business. Nefkens will report to Gary Michel, President and CEO, Honeywell Home and Building Technologies, until the Homes business spins later this year.

Nefkens previously served as Executive Vice President and General Manager, Enterprise Services, Hewlett Packard Enterprise, with direct responsibility for a $20 billion P&L and 110,000 employees globally. He has been recognized widely for the successful turnaround of this business. In fact, he increased customer satisfaction to top of its industry while driving record operating profit improvement for 14 consecutive quarters. Nefkens also led the successful spinoff-merger of this business into DXC Technology in 2017, which resulted in the creation of $14 billion in shareholder value. During this time, he also served on the executive team that spun HP's PC/Printers and Software businesses into standalone public companies. "Mike has demonstrated that he is a smart and strategic leader, adept at building a strong customer-focused culture," said Honeywell Chairman and CEO Darius Adamczyk. "He has a deep understanding of how integrating software platforms and services can deliver the connected solutions that Homes customers require, and we are confident that his appointment – coupled with our recent appointment of Roger Fradin as Chairman of the Board – will position the new company for success."

"I am truly honored to have this opportunity to join one of the world's leaders in supporting the Connected Home and to work with an extremely talented global workforce to enable us to lead the Internet of Things era," Nefkens said. "We have the capability to provide tremendous value for customers in comfort and convenience, security and energy efficiency."

Nefkens has driven the successful turnaround of multiple global businesses in Europe, Latin America and North America. He has 10 years' experience in the energy sector in Latin America, where he held a range of executive management positions. Nefkens is an authority on transformation and cybersecurity. He serves as an advisor to Boards and fellow CEOs and has spoken four consecutive years at the World Economic Forum in Davos, Switzerland. He earned his bachelor's degree in finance from Texas Christian University and an MBA from Duke University. ■

Highest number of Sustainable Buildings in Tamil Nadu

According to the list released by the US Green Building Council (USGBC), Tamil Nadu ranks first among the list of top 10 states in India for highest number of green buildings under Leadership in Energy and Environmental Design (LEED). This is the first time the list has been released in India and it ranks states in terms of gross square feet of energy and environmental design certified space overall.

LEED is a green building rating system. LEED-certified spaces use less energy and water, save money for families, businesses and communities, reduce carbon emissions and create a healthier environment for occupants and the community at large.

With an increase in the number of green buildings in the country, LEED had considered India under the section and has released the list of top ten states. Tamil Nadu topped the list with 118 projects and around 4.9 crore gross square feet (GSF) of LEED certified space, followed by Maharashtra with 205 projects and around 3.6 crore GSF and Karnataka with 149 projects and around 3.5 crore GSF. ■

JLL's Mumbai Office Achieves LEED Gold Certification

JLL, India's largest real estate services firm, adds a unique distinction today as its newest office in Bandra - Kurla Complex (BKC), Mumbai, is awarded LEED Gold Certification for commercial interiors (LEED®- CI). Mahesh Ramanujam, President and CEO, U.S. Green Building Council (USGBC) handed over the prestigious certification in a ceremony held at JLL's Mumbai office. The LEED®- CI certification recognizes an office premise for green tenant improvements, showcasing the occupiers' environmental commitments and leadership in creating sustainable and future ready office spaces.

The office provides for a tech-enabled environment with collaborative zones spread over 22,000 sq ft of prime, 100% environmentally sustainable work spaces. It has been specifically designed to provide a superlative working experience to boost productivity in tandem with wellbeing. In the face of evolving client expectations, this new innovation centre is a live model of the Future of Work and Human Experience - Concepts which will be the base for future modern workplaces, of which JLL is a strong advocate in this age of disruption. ■

Energy Efficient Stanford Children's Hospital

The hospital in Palo Alto, Calif., which opened in December 2017, is one of just five new hospitals — and the second children's hospital — in the world to earn the USGBC's Platinum designation, according to the hospital. Innovative systems were built into the 521,000-square-foot building and 3.5 acres of gardens and green space to achieve the highest possible sustainability standards and to reduce energy and water use. As a result, Packard Children's overall energy consumption is expected to be reduced by 60 percent and its water consumption is expected to drop by nearly 40 percent compared to regional hospital averages, officials said.

Designers estimate that overall the hospital has reduced its carbon emissions by 90 percent compared to the average US hospital. Packard Children's Hospital is the first major hospital in California to implement the use of a displacement ventilation system and the first hospital in the country to use it in all acute care patient rooms. Displacement ventilation foregoes the traditional approach of blowing cool air from ceiling registers, which requires more energy to push the air down. Instead, it brings air into rooms at the floor level. Displacement ventilation also improves indoor air quality and reduces audible ventilation noise. A distinct feature of the building's facade are the horizontal orange slats, called louvers, positioned like awnings across the top of each window. ■

LOUVER TYPE MIST COOLING SYSTEM

For

CHILLERS

A Superior Alternative to Cooling Tower

▲ *Louver Type MCS*

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

Other Superior Features of LTMCS

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

Over 300 installations

Typical case study data of a 1200 TR Chiller

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

MIST imitating nature

Mist Ressonance Engineering Pvt. Ltd.

Regd Office : 'Anandi', 1304-1/7, Shukrawar Peth, Bajirao Road, Pune - 411 002. INDIA.
Tel : (+ 91 20) 2447 2726 / 2447 1184 ■ Fax : (+91 20) 2447 4972
E-mail : mistcreation@gmail.com ■ mistcool@vsnl.com ■ Website : www.mistcreation.com

COOLING TECHNOLOGY INSTITUTE CTI MEMBER

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