

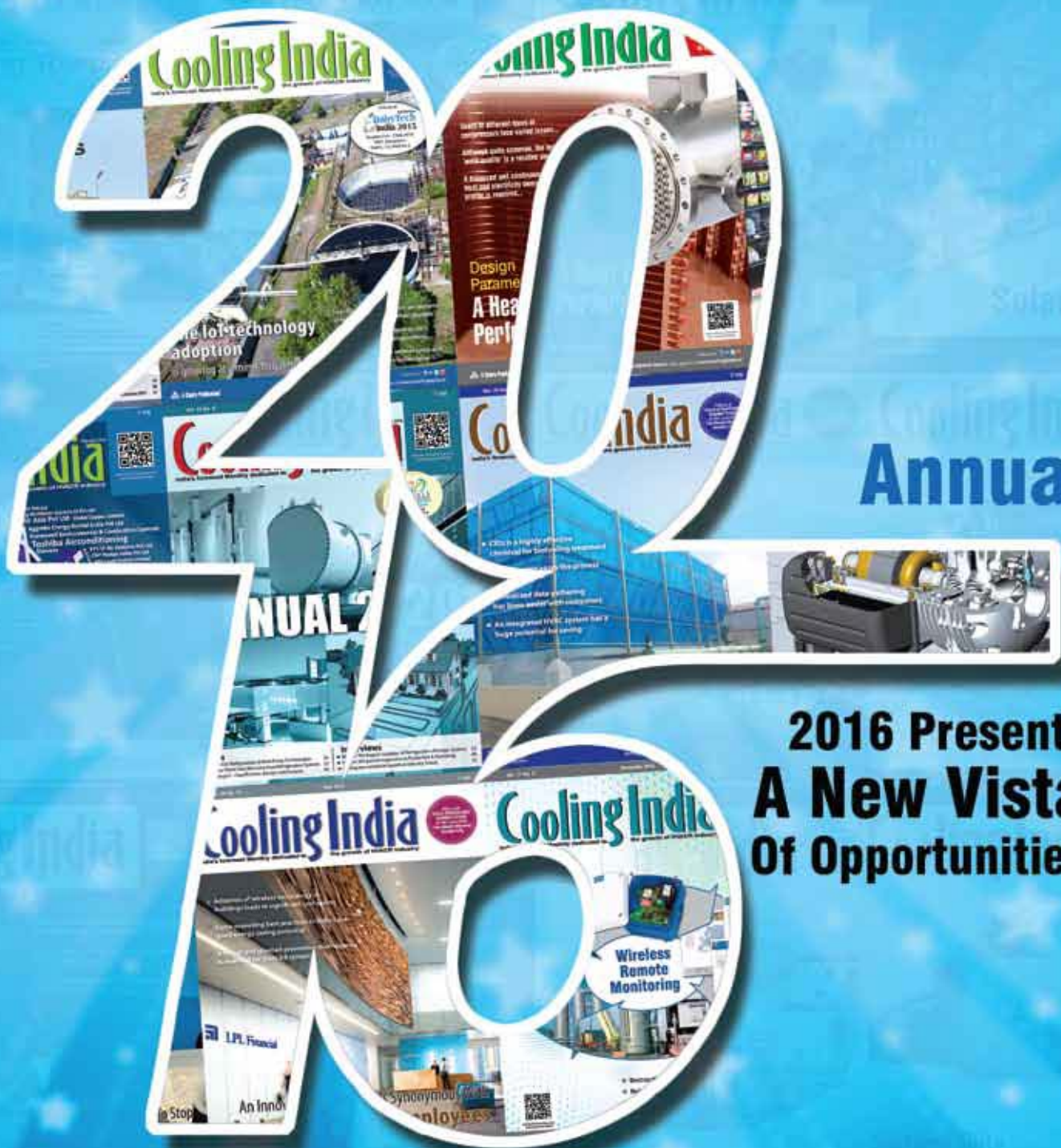
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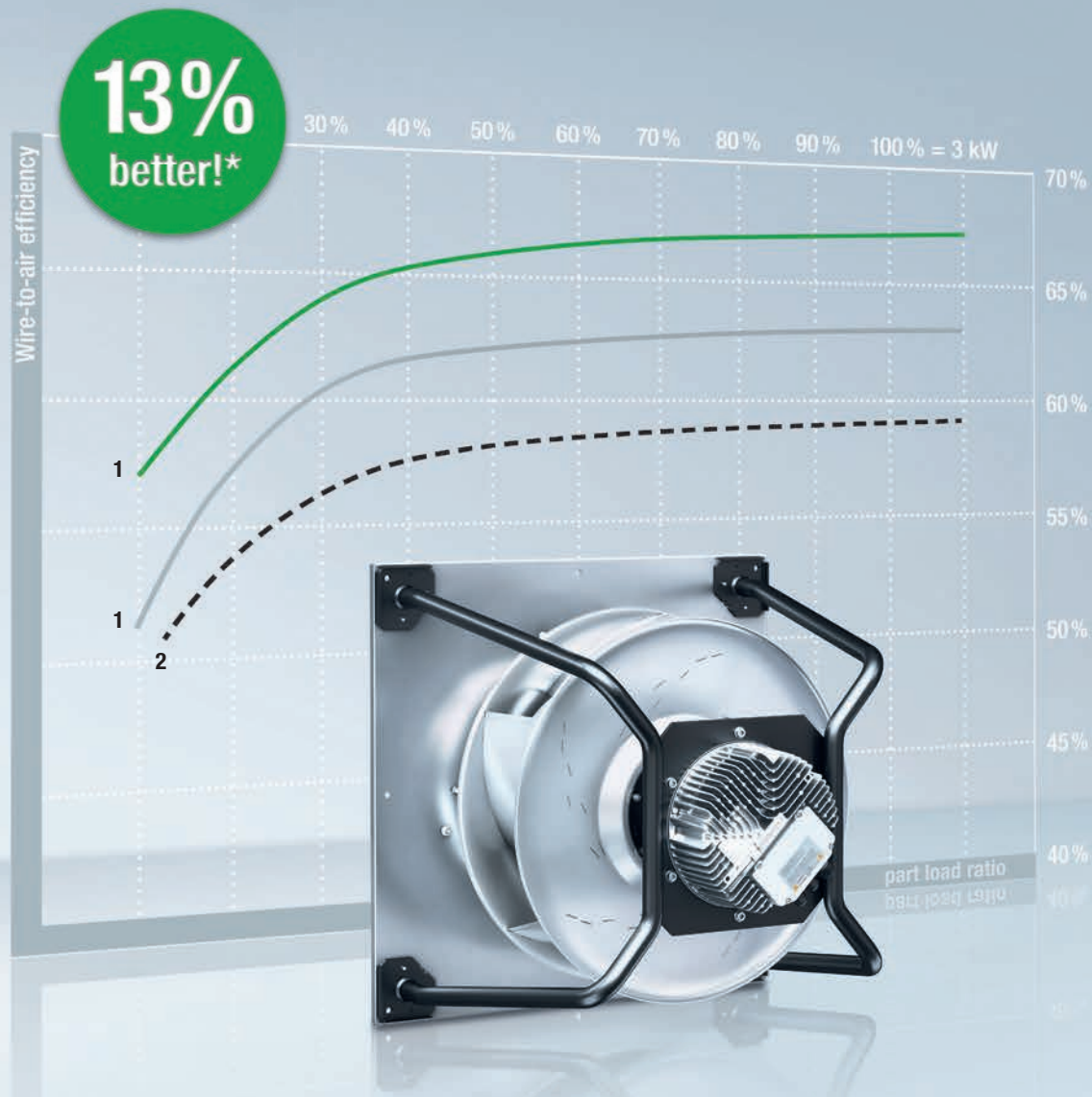


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# Publisher's Letter



## Publisher's Letter

### Innovation Will Be The Key To Win

**A**lthough the proposed US\$ 20bn project in Dubai, i.e., the 4.5 square kilometre, glass-dome-covered development; a place full of shops, offices, hotels, apartments and entertainment facilities; have been scaled down, the news at the beginning of 2016 need not be interpreted as a setback to the global HVAC industry. After the Paris summit, a new vista has opened up, wherein the OEMs and system developers will find a major market in commissioning energy efficient, alternative energy-based and highly automated cooling systems – not only in growing commercial and shopping centres but also in residential sector.

In fact, the decision of splitting up the mega project in Dubai into three smaller shopping centres, and the proposal for scaling up the construction as per growth in demand and pumping of money clearly indicates that the investors are still not ready to step out of their calculated risk acceptance policy.

However, global warming process will continue, and that will necessitate such projects in the coming days. If not at one place, the concept of big centrally, air-conditioned market zone (city) will spread further, and several developing countries will plan such mega projects in order to draw benefits of the use of large scale renewable projects.

Yet another emerging area in 2016 will be the energy efficiency projects and retrofits in the residential sector. Not only the equipment suppliers but also the HVAC service sector will see a big chunk of silver here – because of the compliance rules that are being formulated in most of the countries.

There will be a big change in business pattern as well as product design and manufacturing to comply with the new regulations or guidelines. So, innovation will be the key to win in the coming days.

Please send your comments at [pravita@charypublications.in](mailto:pravita@charypublications.in)

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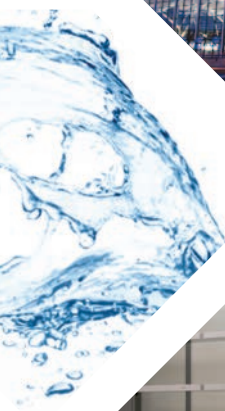
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# FROM THE EDITOR



## Three Pillars Of Success

From the available research reports and other sources of information, it is evident that in 2016 the HVAC market will witness a good growth rate at almost all parts of the world. The recent report from 'Research and Markets,' a leading provider of market research reports and industry analysis on products; states that the North Africa HVAC Market is witnessing a high demand for mini-split air conditioners and is expected to generate over \$891.48 billion value by 2022. Other products that follow the high surge in the usage of HVAC products in the region include Air Handling Unit (AHU) and Fan Coil Unit (FCU). Rising population, revival in the housing markets, growing commercial and industrial units are some of the key drivers pushing towards the growth of North Africa HVAC market.

Research and Markets categorically states, "The demand for HVAC products in the region are forecasted to remain high for various applications including commercial, residential, industrial and institutional among others. The government regulations, latest energy-efficient building criteria and growing consumer concerns are pushing HVAC manufacturers, developers and system integrators to build and provide cost-effective, energy efficient and technologically advanced HVAC products for major end-use applications in North Africa market."

Tech Navio (through Reportlinker), a leading technology research and advisory company with a global coverage, also predicts that the global split air conditioning market will grow steadily at a CAGR of nearly 6% by 2020. Rising global population coupled with the high demand for air conditioners from residential and commercial buildings will foster the prospects for market growth during the predicted period. Thus, there is enough reason to believe that the market is throwing up many exciting opportunities. But the customers for the comfort zone machines are now more demanding, thus they will seek several additional features in the new products. Energy efficiency, Environment friendliness and Feature richness will be the three pillars of success in 2016 for any aspiring market player.

Pl. send your views at [pkchatterjee@charypublications.in](mailto:pkchatterjee@charypublications.in)

*P. K. Chatterjee*



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## Daikin declares its action plan to save environment

**D**aikin Industries Ltd. has recently launched a new global publication explaining its policy and actions related to the environmental impact of refrigerants. While Daikin is known as the first manufacturer to launch residential and commercial air conditioners / heat pumps using the refrigerant HFC-32, this publication takes a much wider focus.

It explains Daikin's general considerations for making a refrigerant choice, and the refrigerant direction for the whole Daikin portfolio, including VRV, Applied and Refrigeration products. The publication also explains the role of the company and its stakeholders to reduce the environmental impact during the entire refrigerant and equipment lifecycle.

Daikin has a long history of continually reducing the environmental impact of cooling, heating and refrigeration products, as well as having a unique expertise that comes from manufacturing both equipment and refrigerants. This is a result of the company's corporate philosophy to "Be a Company that Leads in Applying Environmentally Friendly Practices."

Regarding refrigerant choice, Daikin has expertise in using fluorinated (HFC, HFO) as well as non-fluorinated gases (Ammonia, CO<sub>2</sub>, hydrocarbons), because the company believes in diversity of refrigerant choice to allow the best suited option to be used in each application.

Taking a comprehensive approach, Daikin evaluates four basic factors when making a refrigerant choice: safety, environmental impact, energy efficiency and cost-effectiveness. This publication explains in more detail what this entails, and gives some practical examples from the Daikin product portfolio. The publication can be downloaded from: [http://www.daikin.com/csr/information/influence/Daikin's\\_Policy.pdf](http://www.daikin.com/csr/information/influence/Daikin's_Policy.pdf). ■

## Rolls-Royce delivers gensets to hospital in Kuwait

**R**olls-Royce is delivering 23 MTU Onsite Energy standby gensets as part of the expansion and modernisation of the existing Al Farwaniya hospital in Kuwait City by the Kuwait Ministry of Health, due for completion by mid-2019. The brand MTU Onsite Energy is part of Rolls-Royce Power Systems within the Land & Sea division of Rolls-Royce.

MTU Partner Albisher & Z Alkazemi Company (A&A) recently closed the deal for delivery of the 23 gensets with prime contractor

Sayed Hamid Behbehani & Sons Co. (SHBC) in Kuwait. The diesel-powered gensets based on MTU Series



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"In case of any instability in the power supply, the 23 gensets keep the hospital running smoothly by delivering some 50 MW of power in a matter of seconds. With ambient temperatures ranging as high as 55°C, keeping the hospital's air-conditioning system up and running is crucial," said Ashraf Tamim, General Manager of A&A. ■

## ISHRAE launches Job Junction

**I**SHRAE, the Indian Society of Heating, Refrigeration and Air-conditioning Engineers, has launched Job Junction, an initiative to facilitate employment for fresh graduate engineers and diploma holders. Job Junction will act as an interface between prospective employers and students seeking employment.

Job Junction has organised several employer-student engagement programmes across cities scheduled to take place in Delhi, Kolkata, Mumbai, Nagpur, Indore and Bengaluru. The engagements will take place in this month (January 2016). Through this initiative ISHRAE will focus on providing job opportunities for students in various categories that include Sales Engineer, Marketing Engineer, Project Engineer, Production Engineer, QA Engineer, Service Engineer etc.

Announcing the launch of Job Junction K Ramachandran, National President, ISHRAE stated, "Through Job Junction, ISHRAE endeavours to fill the skill gap in the HVAC-R sector – will look to harness the talent pool India has to offer to both domestic and global manufacturers." ■

## Solar Hippo helps customers enjoy a clean environment

**S**olar Hippo has added a new category- Air Purifiers. The marketplace offers a wide range of air purifiers starting from Rs. 4,500/- that ensures clean, germ-free and unpolluted environment. With the increasing pollution levels especially in the urban areas, there is greater need to purify air for the health and well-being especially of kids, old persons and people affected with respiratory disorders.

The contemporary air purifiers are equipped with the latest technology like HEPA (High Efficiency Particulate Air) and advanced purification system to keep away germs. The air purifiers offer efficient Clean Air Delivery Rate (CADR) and air flow rate. It also shows ACH (Air Changes per Hour) which indicates the number of times the entire volume of air inside a room is replaced during the course of one hour. The higher the number of changes, the better it is.

Commenting on the recent addition in company's product portfolio, Rajiv Kumar, Founder & CEO, Hippo Innovations Pvt. Ltd., parent company of Solar Hippo said, "We are excited to launch a new category of Air Purifiers, and it has some of the best in category products that have been designed considering the Indian eco-system. At Solar Hippo, we remain committed to provide our customers with products that can complement their lifestyles while ensuring a cleaner environment. With the alarming pollution levels across India, we are hopeful that with our latest offering customers will be able to breathe fresh and healthy indoors. Air Purifiers come as an extension to the brands' focus to offer a strong product portfolio that can help customers experience a clean environment."

Customers will be able to choose from a variety of affordable high grade HEPA purifiers and de humidifiers that will be available in different sizes and forms – whole house, single room, mini air purifier, floor mounted, table top. The Air Purification Systems available on the platform are based on the principal of PCO (Photo-Catalytic Oxidation using UV) along with high grade HEPA & carbon filter- to neutralise allergens like dust, pollen, smoke, odour, bacteria, virus, other micro-organisms, and toxic gases. ■



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## J Samuelson to be the new President, CEO of Electrolux

The Board of Electrolux has appointed Jonas Samuelson as new President and CEO of Electrolux as of February 1, 2016, following Keith McLoughlin's (presently holding the post) notification to retire from Electrolux. Samuelson is currently Head of the business area of Electrolux Major Appliances Europe, Middle East and Africa. He has previously been the Head of Electrolux Global Operations – and prior also held the role as Group Chief Financial Officer. He joined Electrolux in 2008.

"With the dedication of the entire Electrolux team, we have strengthened this great company by substantially increasing our investments in consumer-led innovation, focusing on



**Keith McLoughlin,**  
(Current) President &  
CEO of AB Electrolux

profitable growth areas and leveraging the scale of the company through global integration. With this strong foundation in place, and having a well prepared internal successor in Jonas, it is now time for me to pass the baton and return to my family in the US," says McLoughlin.

Ronnie Leten, Chairman of the Board of Directors of Electrolux says, "Keith has made significant contributions in strengthening the company during his time



**Jonas Samuelson,**  
(next) President &  
CEO of AB Electrolux  
**Keith McLoughlin**

as CEO. Under his leadership, Electrolux has successfully enhanced its position as an innovative, globally integrated company, while strengthening its balance sheet. His personal integrity, commitment and loyalty to this company have been well appreciated. I enjoy our relationship and I am looking forward to continuing it. (Also,) The Board is pleased that Jonas Samuelson will take on the role as President and CEO for the Group. His focus will be to continue executing the Electrolux strategy of becoming a truly consumer driven company leveraging our global scale."

## Liebherr supplies heating systems, AC units to Hochbahn

Liebherr-Transportation Systems; a company offering a wide range of highly integrated, leading-edge technology systems and equipment to train manufacturers and operators; recently signed a contract with Bombardier Transportation to manufacture AC units and heating systems for another 33 underground trains of the type DT5.

Each train will be equipped with three air conditioning units for the passenger compartment and two for the driver's cabin. The heating systems, which use the waste heat from traction, are designed for the passenger compartment. The trains will be operated by Hamburger Hochbahn AG in Hamburg, Germany. All the units should be delivered by July 2017.

"This contract strengthens the position of Liebherr-Transportation Systems as the leading supplier of AC systems on the German market. It is another milestone in our long and successful partnership with Bombardier Transportation," said Dirk Junghans, MD, Sales, Marketing and Customer Services at the company.

## IEAQ technology market to expand

A new report from Navigant Research has examined the market for Indoor Environmental And Air Quality (IEAQ) technologies used in new construction and retrofit applications, with global forecasts for revenue, segmented by region, building type, and technology, through 2024. The report states, healthy and green buildings rely on good IEAQ to maintain the wellness and productivity of their occupants. Related IEAQ technologies can provide the measurement and verification of ventilation and moisture management, indicating whether appropriate conditions have been achieved and maintained indoors. According to the new report, the global IEAQ market is expected to grow from \$4.2 billion in 2015 to \$7.1 billion by 2024.

"In order to effectively maintain a healthy indoor environment without compromising energy efficiency, building owners are turning to many new IEAQ technologies. IEAQ systems are developing rapidly, and the most sophisticated ones integrate with BEMSs and HVAC systems to improve IEAQ without increasing the carbon footprint," says Anne Wrobletz, Research Associate with Navigant Research.

## Aerahaas partners with Tado to deliver 'smart AC control'

Singapore smart homes solution provider, Aerahaas, is now the official and exclusive distributor of tado° in Singapore. With this partnership, Aerahaas aims to empower all home owners with smart home technology and convenience.

The Smart AC Control turns air conditioners into smart devices by automatically saving energy when the user is away while ensuring a cool home when they return. Tado works by using a user's smartphone's location to automatically adapt their air conditioner to their behaviour.

The geo-aware app on their phone senses when they leave the house and turns off the air conditioner. As soon as they start approaching home, tado starts pre-cooling so the user always come back to a comfortable house, without having to lift a finger. With its fully automatic climate control, tado not only makes their home more comfortable, but also helps them save up to 40% on energy costs.

Aaron, Project Manager of Aerahaas, commented, "Our cooperation with Tado GmbH is definitely another milestone for us. Essentially, the Tado Smart AC control bridges the gap between smart living and user friendliness. It relieves the user of costly set up, programming services through a simple app that takes less than 5 minutes of your time." The tado app can be downloaded free for iOS and Android, with a Windows Phone app coming soon.

"With its all year round warm temperatures, Singaporeans have been demanding a smart solution like this. With this partnership, we're looking forward to saving Singaporeans money and increasing their convenience while reducing overall emissions for a cleaner and greener city." adds Aaron.



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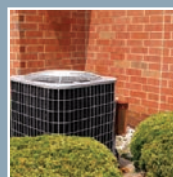
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For more information, or to join a free webinar, visit [www.microgroove.net](http://www.microgroove.net)



## Samsung Electronics rolls out new refrigerators

Samsung Electronics, a global leader in home appliance innovations, has recently introduced a brand new refrigeration category to the market that cements the refrigerator's position as the center of the kitchen.

With practical innovations infused throughout, Samsung's latest kitchen appliances have been unveiled alongside its other home appliance introductions, at the CES 2016 from January 6 to 9, 2016. The Samsung Family Hub Refrigerator is a sophisticated multi-tasker that reconnects families, organizes groceries and home tasks, and provides entertainment.

"Samsung has strongly reinvigorated the home appliance space with fresh thinking and functionality that have taken appliances from a 'need' to a 'want.' With the new and innovative Family Hub Refrigerator, we are transforming the communal kitchen experience for consumers in ways that will re-define how they view and use their refrigerators," said John Herrington, Senior Vice President, General Manager of Home Appliances, Samsung Electronics America.

"Now more than ever, we are delivering in a big way on the promise of the Internet of Things, not only in refrigeration but in cooking, with a new Wi-Fi-connected range that takes cooking convenience to a new level," he added. ■



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## Zamil Projects receives contract from SEPCO

Zamil Projects, a business unit of Zamil Air Conditioning and Refrigeration Services Company, has been awarded a new contract worth SAR 25.4 million (US\$ 6.8 million) from China's Shandong Electric Power Construction Corporation (SEPCO) to provide engineering, procurement, and construction services, as well as mechanical works, for the HVAC systems and equipment at Saudi Aramco's Master Gas System Expansion (MGSE) project in Saudi Arabia.

Under the contract with SEPCO, Zamil Projects will supply an assortment of HVAC equipment and custom power and control panels. Zamil Projects will also perform all essential HVAC system engineering, supply, installation, testing, and commissioning services for various buildings and compression stations at the MGSE project. Scheduled for implementation in phases, the MGSE project is one of the world's largest hydrocarbon networks and provides vital support for the development of Saudi Arabia's non-associated gas, unconventional gas, and related condensate reserves. ■

## U-Line's Modular 3000 Series products receive awards

U-Line, the American company in premium built-in modular ice making, refrigeration and wine preservation products, has been awarded by Awards for Design Excellence (ADEX) with three 2015 Platinum Awards. U-Line's Modular 3000 Series 24" Independent Dual-Zone Wine Captain Model (3024ZWC), the Modular 3000 Series 24" Frost-Free Freezer (3024FZR), and the Modular 3000 Series 24" Independent Dual-Zone Drawer Model (3024DWR) each received the 2015 ADEX Platinum Award for Design Excellence. ADEX is the largest and most prestigious award programme for product and project design in the architecture and design industry.

"We are honoured to receive three 2015 Platinum Awards for Design Excellence for our U-Line Modular 3000 Series products," states Mark Russell, VP of Sales and Marketing for U-Line. "Industry professionals and customers alike have recognized that U-Line's point-of-use modular refrigeration allows you to re-imagine your space by organising the right products in the right place at the right temperature. U-Line Modular 3000 Series products are comprised of our ultra-premium product offering and are designed to provide the ultimate in point-of-use flexibility. These models are the most innovative, highly featured refrigeration and ice making products in the modular appliance industry."

The Modular 3000 Series actively maintains a stable temperature to ensure proper preservation while sustaining temperatures to within 1°F of the set point, providing the optimal environment for your food and beverages. The models seamlessly integrate into a standard 24" cabinet depth, and are available 18", 24", and 36" cabinet widths. A zero clearance, flush installation is easily achieved with concealed and covered hinges, a front ventilation system, adjustable and integrated panel ready toe-kick and doors, four independently adjustable leveling legs, and rear legs that are accessible and adjustable from the front of the unit. ■



**Modular 3000 Series, 3024ZWC 24" Wine Captain Model...**

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**Sanjeev Sharma**

**He brings extensive experience in industrial automation and electrification across market segments and geographies...**

## Sanjeev Sharma takes over as Managing Director of ABB India

**A**BB India Limited has appointed Sanjeev Sharma as the Managing Director, with effect from January 1, 2016, to continue the path of next level of growth across utilities, industries and infrastructure in the country.

Sharma first joined ABB in 1990 and since then has held a number of global senior management roles. He brings extensive experience in industrial automation and electrification across market segments and geographies – and has led several successful change management initiatives across global operations. Prior

to this appointment, Sharma was the global Managing Director for ABB's Low Voltage Systems business unit, where he was based in Malaysia. He started his career working for ABB in India and has also lived and worked in Germany and Switzerland.

"Sanjeev brings over 25 years of experience in ABB in diverse roles across various locations and functions, where he has most notably been responsible for running successful global business units," said Frank Duggan, Chairman of the Board, ABB India Limited. ■



**Tim Rook**

**He was previously head of build design at Eon Community Energy, where he led a team of engineers in the design and delivery of ecentralised energy systems...**

## BESA fills up the senior post of Technical Director

**T**he Building Engineering Services Association (BESA) has appointed Tim Rook to the new senior post of Technical Director. Tim Rook was previously head of build design at Eon Community Energy, where he led a team of engineers in the design and delivery of ecentralised energy systems, including: London's Citigen, which features 9MW of combined heat and power supplying a 25MW heat and 10MW chill district system; the UK's first commercial solar thermal plant; and some of the largest residential district heating systems.

Tim is a member of the Institute of Mechanical

Engineers and the Chartered Institution of Building Services Engineers, and has worked in a wide variety of M&E contracting businesses as well as manufacturing, the energy industry, with particular emphasis on renewable and environmental technologies, most notably biomass, heat pump and photovoltaic systems.

"I am confident that Tim's excellent academic qualifications and broad practical and managerial experience will prove an invaluable asset to the association," said BESA's Chief executive Paul McLaughlin. ■



**Brian King**

**"IACSC member companies need to stay on the cutting edge of new technologies," he says...**

## IACSC elects its new Chairman for 2015-2016

**N**ew officers and board members of the International Association for Cold Storage Construction (IACSC) were elected at the IACSC Conference & Expo, which was held in November 5 to 7, 2015, in Las Vegas, Nevada. Brian King of A M King was elected as the 2015-2016 Chairman of International Association for Cold Storage Construction (IACSC).

IACSC also recognised outgoing IACSC Chairman Erik Gunderson of Primus Builders for his leadership during the past year.

Founded in 1978, the International Association for Cold Storage Construction (IACSC) represents contractors and suppliers in the cold storage construction industry. IACSC provides a forum for innovative ideas, promotes standards of practice,

hosts professional education programs, and promotes the interests of the industry in political, legal and regulatory arenas. Today, IACSC has members all over the world and is a Core Partner of the Global Cold Chain Alliance.

"The IACSC leaders that came before me have put the organisation in the strongest position it has ever been, and I hope to build on that legacy. As customer needs and priorities evolve, IACSC member companies need to stay on the cutting edge of new technologies and construction methods. With the upcoming slate of education, networking and research, we are poised to do that successfully," King said. ■

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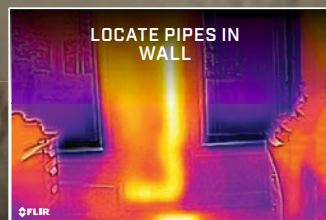
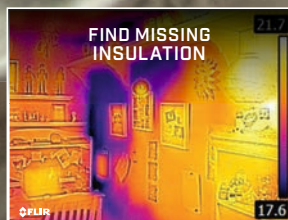
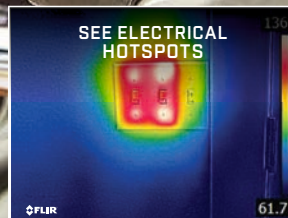


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# Indian Market For Air Purifiers To Witness Growth



<http://aliveairpurifier.com>

**Northern region boosting the market for air purifiers in India communicates the research report titled 'India Air Purifier Market (2016-2022)' published by 6Wresearch...**

**I**ndustrialisation, growing urbanisation, dependency on non-renewable sources of energy, rising pollutants, and growing number of vehicles have significantly deteriorated the quality of air across India. In addition, dust from construction activities is further degrading the air in all major cities. These factors have resulted into the usage of air purifiers in India. Also, rising number of individuals suffering from respiratory diseases has become another major factor which is driving its penetration.

According to 6Wresearch, India Air Purifier Market is projected to grow at a CAGR of 37.6% during 2016-22. India's air purifier market is in its nascent stage, primarily confined to metropolitan cities only owing to rising pollution index, health related issues and growing awareness amongst consumers. Northern region specifically is registering major demand for air purifiers in India. Delhi has emerged as one of the most polluted cities in the world, which is witnessing substantial demand for these purifiers. The air pollution Particulate Matter (PM) 2.5 levels in Delhi were at 295 microgram/m<sup>3</sup> and PM10 levels at 470 microgram/m<sup>3</sup> in December 2015, which is considered to be 'Hazardous' as per international standard mentioned in Global Air Pollution Index.

According to Avishrant Mani, Senior Research Analyst, Research and Consulting, 6Wresearch, "Government, residential and healthcare applications are the major revenue contributing applications in the overall India's air purifier market. Expats and affluent class are the key consumers due to high prices of the devices. However, market has

started shifting towards middle class group as well on the back of declining prices of the purifiers."

"Moreover, rising disposable income and changing lifestyle is expected to stimulate the growth of air purifier market in the coming years. During the forecast period, Indian air purifier market is anticipated to witness strong growth on account of increasing adoption end user in hospitality, commercial and other applications including educational institutes and health clubs," Avishrant added further.

According to Sathi Paul, Research Associate, Research and Consulting, 6Wresearch, "Northern and western regions are the key revenue generating regions in India's air purifier market. Delhi and Mumbai have led for the growth of these regions. Government initiatives, implementation of strict rules to curb air pollution and rising health concerns particularly in northern region would contribute to growth of the market over the next six years."

"Southern region would be the second key contributor of air purifier market in the coming years owing to intensifying level of air pollution mainly in Bengaluru, Mysore, Coimbatore, Hyderabad, Chennai and Thiruvananthapuram," Sathi concluded.

India's air purifier market is led by players such as Sharp, Eureka Forbes, Philips and Blueair, which have captured significant share of the market revenues. Other players include - Crusaders Technologies, Daikin Air Conditioning, LG, Honeywell, Kent RO Systems, Panasonic and OSIM International. ■

# AC Machines To Witness Growing Demand

*India air conditioner market is projected to grow at a CAGR of 10.2% during 2015-2021: 6Wreaserch...*

**G**rowing retail & hospitality sectors, construction & expansion of airports & metros, establishment of SEZs & commercial hubs and building new housing societies have fueled the market for air conditioners in India.

Growth in the construction market and increasing government spending towards public infrastructures have further spurred the market. Though the prices of air conditioners are increasing in India but companies are offering various kind of schemes – such as EMI and seasonal discounts, which are highly attracting middle class population of the country.

According to 6Wreaserch, India air conditioner market is projected to grow at a CAGR of 10.2% during 2015-2021. India air conditioner market is a highly competitive and fragmented market with presence of domestic, international and unorganised market participants.

In 2014, room air conditioner market accounted for major revenue share followed by central air conditioning systems.

In room air conditioner segment, split air conditioner market dominates – and would continue to lead through the forecast period. The demand for these air conditioners is primarily growing in the residential market. ■



# The Emerson Cup Draws Outstanding Design Ideas

***The Emerson Cup 2015 introduced Product Innovation as a new category. This is in recognition of changing customer expectations...***

Emerson Climate Technologies, a business segment of Emerson, instituted The Emerson Cup, which is HVAC&R industry's one of the most sought after awards that encourages and rewards exceptional talents. The annual design competition successfully launched from China in 2003, completes its 8<sup>th</sup> consecutive appearance in India this year. The gala award night saw outstanding design ideas being recognised and rewarded by HVAC&R industry stalwarts.

The Emerson Cup 2015 introduced Product Innovation as a new category. This is in recognition of changing customer expectations and a strong need to provide impetus for the introduction of innovative products in the country.

Addressing the audience, Sridar Narayanswami, Vice President & Managing Director, Emerson Climate Technologies, said, "The HVAC&R industry is a major player in the quest to make the green building movement successful. It presents exciting opportunities in energy efficiency and improvement of indoor air quality. This is where The Emerson Cup helps by becoming a catalyst in promoting new-age technologies and recognising talent within the industry. We believe, The Emerson Cup provides a major fillip to the betterment of the HVAC&R

industry by providing a platform for young designers. The grand success of The Emerson Cup is indeed a proud moment for all of us at Emerson Climate Technologies."

The Emerson Cup 2015 incorporated four Award categories:

1. New Project - Metropolitan & Emerging Cities
2. Retrofit Project - Metropolitan & Emerging Cities
3. Cold Chain Project - Metropolitan & Emerging Cities
4. Product Innovation In Cold Chain & Air conditioning

The New Project award category continued to witness the highest number of nominations.

This year (2015), the excellence award – Metropolitan Cities was conferred on STERLING INDIA, for the Spire Edge, Manesar project, while the Emerging Cities award was presented to RELIANCE INDUSTRIES LIMITED for their Reliance Data Center, Jamnagar project.

There was enthusiasm for the Retrofit Project category award as well, with the excellence award jointly presented to GODREJ & BOYCE MFG. CO. LTD. for Up-Gradation of HVAC system at Godrej-MHE, Vikhroli and FOOTPRINTS E.A.R.T.H., Ahmedabad for their project at Evolutionary System Private Limited, Ahmedabad. The Retrofit Project-Emerging



*Dr P C D N is addressing the audience.*

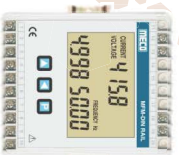


*Sridar Narayanswami is addressing the audience.*



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**Pankaj Dharkar & BB Kale Presenting the Cold Chain-Product Innovation Award**

Cities category was won by Vodafone South Limited for the project Vodafone Mobile Telephone Exchange, Hubli.

In the Cold Chain–Metropolitan Cities category, Hindustan Unilever Limited won the excellence award for their HeartICE, Mumbai project. While the Cold Chain – Emerging Cities category was won by MEGASTAR ENGINEERING for their project Refrigeration System at Real Dairy, Baramati.

The category - Product Innovation introduced this year, received a thumping response from the industry, going by the number of entries it attracted. The Product Innovation - air conditioning category saw Blue Star Limited bagging the award for its Precision Packaged Chiller for MRI Scanner. Exercising their discretion, the Judges instituted a Jury's



**The Jury Members in the event.**

Special Award under the Product Innovation - air conditioning category and presented it to Panasia Engineers Pvt. Ltd., Mumbai for their entry of An Innovative Triple Mode Cooler.

The Product Innovation in cold chain category also saw a Jury's Special Award being conferred to Milk-Tech Engineers & ICRI–NDRI for their product Milk Cooling Module.

The awards were selected by a distinguished panel of judges, comprising a team of highly recognised and influential doyens in the field of energy efficiency, engineering, architecture, education and HVAC&R Design.

The Emerson Cup is increasingly being recognised as an initiative that is setting benchmarks, which help drive innovation in the industry. ■

## company profile

# A One Stop Solution Provider For All Your Refrigeration Needs

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The Company also deals in Technological Products like Steam Humidifier, Adiabatic Humidification & Misting System, Refrigerant leak detection system for VRF & Chiller Projects.

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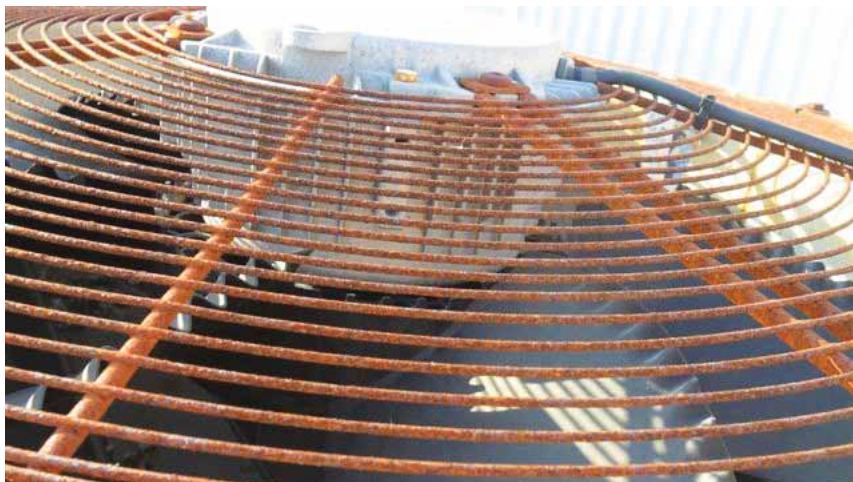
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# Heating, Ventilation And Air Conditioning (HVAC)



## ***HVAC finds its origin in the Indian economy, with the stupendous growth of various industries viz. pharma, IT, software...***

**D**oes buying best rated technologically advanced Heating, Ventilation and Air Conditioning (HVAC) equipments ensure best results and benefits continuously?

No. If an Economic Times article is to be believed, leading luxury hotels, malls, IT industries, etc., are being told by the management to prune power bills by 15 to 25%. This leads us to ask some important questions like why is such heavy investment in HVAC not paying back? Why is a project with 125% AC capacity, facing cooling issues after a year of use? Why is it that during the Indian summer various reports on maximum compressor failures have been reported in Northern India and other scorching regions of the country?

HVAC industry has grown by leaps and bounds in the last two decades. HVAC finds its origin in the Indian economy, with the stupendous growth of various industries viz. pharma, IT, software, manufacturing growth, industrial expansion, outsourcing, mall, retail, entertainment, education, realty, rise in individual earning, rise in temperature etc.

HVAC industry brought with it new players, new technology, new models, gold standards and competition. EMI and competitive prices made the industry penetrate deeper than ever before.

Having been a successful industry in the past and the growth pattern maturing at the present rate, there is an increase in the demand for performance.

A great question to ask will be – if the HVAC industry has survived the recession of 2008; will it be able to expand heatedly in the future?

More queries, probing questions and demands from customer, management, environment, financial updates are asked in this hour. The major source of drain on balance sheet is the salary bill – second only to the power bill.

It has been noted that in some cases HVAC consumes 65 to 75% power. High power tariffs and shortages are adding to the woes of the company costs. Thus, HVAC consumers and suppliers alike need to start thinking of ways and means in order to stay afloat.

The major pressure has always been on the completion of the project on time and handing over the site to the original owner. In order to achieve the target dates, only project work conveniences are looked forward to at the cost of maintenance requirement per need. It will be interesting to note that at some places, basic need of power connection, running water, proper drain facility, etc are ignored.

Similarly, HVAC equipment requires space and urban center realty rates are sky high, so every inch of space cut saved is making maintenance of HVAC equipments after installation a steeper work. Some sites require crawling on your knees and hands or standing on 1 - 2 story high ladder to service AHU.

Air and water are being used vastly as a coolant, for heat exchange. Air and water borne contamination build up takes place in such

conditions, seriously retarding their performance, and hence the output. HVAC Units' performance and efficiency are directly proportional to the use of water and air quality, both of them rapidly deteriorating by scales and environment corrosion.

New industry brought new working standards, viz. Call Centers, IT Industry etc. All round working was rarely seen with any alternate cooling arrangement, any failure due to known or unknown factors leads to the collapse of HVAC system – affecting the organisation's productivity. In simple words, imagine people working with no fans and windows in modern architectural structures.

New technology brought about more cooling in compact units, leading to more fins per inch. Types of fins; like slit fins and fine fins, blue fins etc.; became available. Such new technologies with no maintenance guidance or professional equipment from dealers lead to the failure or rejections of many new models in a short period of time.

Hence, the questions to be asked at present are:

- Has the maintenance industry team worked in tandem with the high growth? Are they ready for new technological advances and the work load that will follow?
- Is the maintenance crew technically equipped with the latest gadgets – or are they still employing primitive methods like the wire brush, air blower and caustic soda for cleaning?
- Is it possible to get continuous cooling, high power efficiency, and longer inventory life in the present scenario?
- Is the management right in asking for 15 to 25% power savings? Considering, savings of Electricity + Gas + Water = Power Savings...
- Can maintenance team rise to the occasion and demands of the industries? If yes, how do they plan to? What will they need?
- Can Indian 'Jugaad' be useful? What is at risk and at stake?
- Is it possible to maintain HVAC equipments at original conditions through out their life?
- Can 15-year-old equipments be restored to original conditions?
- Can we extract 2 to 5°C less cooling demand than the present requirement?

To question and get answers to many such issues, please read my next series of articles in Cooling India on HVAC cleaning and maintenance. I also request your queries, which may be sent to the editor of this magazine. Wish you all a very happy new year (2016)! ■

**Mahesh R. Mehta**  
EcoChemPlus, Mumbai





# A Glimpse Of The Scenario In The USA

***A recent analysis from Frost & Sullivan, 'North American Combined Heat and Power Generation Market', finds that the market earned revenues of \$1.50 billion in 2014, and estimates this to reach \$1.95 billion in 2021...***

**C**ombined Heat and Power (CHP) accounts for 8% of the United States' (US) electricity generation capacity, but 12% of its annual power generation.

This reflects the longer operating hours of Combined Heat and Power plants compared to plants involved in conventional forms of power generation.

In addition, as an efficient and clean method of generating electric power and thermal energy from a single fuel source, CHP is used in a broad range of sectors.

Approximately 87% of Combined Heat and Power units supply heat and power to industries such as chemicals, paper, refining, food processing and metals. The remaining 13% is employed for commercial, institutional and residential purposes.

A recent analysis from Frost & Sullivan (the growth partnership company focused on helping their clients achieve transformational growth) on North American CHP Generation Market, states that the market earned revenues of \$1.50 billion in 2014, and estimates this to reach \$1.95 billion in 2021.

"Strong government support in the form of tax credits and incentives gives impetus to the use of CHP

systems in North America," said Frost & Sullivan Energy & Environment Industry Analyst Mahesh Radhakrishnan.

"The market will also get a boost from legislation such as the Energy Policy Act of 2005 and Energy Independence and Security Act of 2007, which mandates incentives for CHP and waste energy recovery," he added.

As per the executive order issued by the Federal Government in 2012, 40 Giga Watts (GW) of cost-effective CHP capacity will be added by 2020. This will take US CHP capacity up to 130 GW, with additional potential for 65 GW each for the industrial and commercial or institutional sectors.

Nevertheless, unclear utility value proposition, limited supply infrastructure and inadequate end-user awareness regarding the benefits of CHP systems are hampering deployment rates.

Apart from these challenges, the price of input fuels will play an important role in deciding the growth of the Combined Heat and Power (CHP) market in North America.

"As more than 67% of Combined Heat and Power (CHP) facilities in the US use natural gas as the input fuel, any volatility in its prices could prove detrimental to the market," noted Fellow Frost & Sullivan Energy & Environment Research Analyst Rashleen Nakra.

"Natural gas prices are, however, expected to increase only moderately compared to electricity prices, resulting in positive spark spread and high investments in the CHP market," he added further. ■



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# Making Responsible HVAC Refrigerant Choice

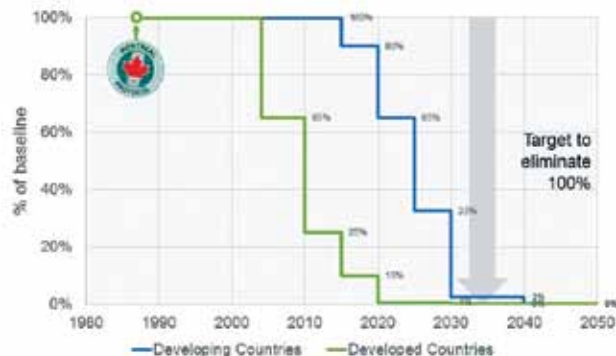
*A majority of the existing systems and equipment in use and available in the market have been optimised for refrigerants such as R-134a and R-410A, with no alternatives able to yet fully match their thermal efficiency and performance...*



*Shanghai Pudong International Airport; one of the world's busiest airports hosting over 40 million passengers annually; employs chillers from Johnson Controls to provide a cool and comfortable environment.*



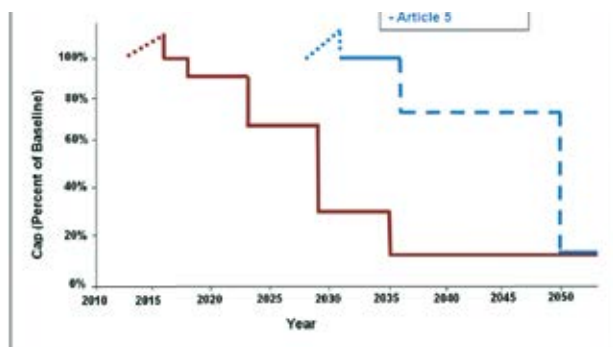
Hydrofluorocarbons (HFCs), commonly used in air conditioners and refrigerators, first became popular in the 1990s when they were used to replace ozone-depleting gases such as chlorofluorocarbons (CFC) and hydrochlorofluorocarbons (HCFC). Under the terms of the Montreal Protocol which was signed in 1987, the CFC and HCFC class of refrigerants are currently in the later stages of being phased out as part of the agreement.



HCFC phase-out schedule. Source: US EPA

High-level discussions among regulatory and government bodies globally on the high Global Warming Potential (GWP) of HFCs in recent years has prompted speculation about the regulatory measures to reduce the use of hydrofluorocarbons (HFCs). The Indian government in particular has taken on a proactive role by putting forward its own proposal to amend the Montreal Protocol and phase-down HFCs, alongside three other different proposals – a joint proposal by US, Canada and Mexico (the North American proposal), a joint proposal by Kiribati, Marshall Islands, Mauritius, Micronesia (Federated States), Palau, Philippines, Samoa and Solomon Islands (the Island States Proposal), and the European Union proposal.

It is noteworthy that among the four submissions, India's proposal was considered to be the most equitable, allowing for a reduction of 55 per cent of HFCs consumption from a business-as-usual scenario. In addition, India's proposal requested for a 15-year grace period for developing countries (article 5 parties) to phase out HFCs and shift to newer technologies, over the deadlines set for developed countries.



Proposal by India: HFC Reduction Step for Non-Article 5 and Article 5 parties (% of baseline). Source: India Environment Portal

Things have continued to progress. A recent meeting by the 197 parties to the Montreal Protocol in Dubai, United Arab Emirates, in the last quarter of 2015 saw members agree to begin work on an

amendment to reduce the global production and consumption of HFCs by the end of the current year. This has only served to stir up confusion around the status of HFC refrigerants and potential alternatives for new HVAC equipment.

## What are the Viable Alternatives to HFCs Available in Market?

A variety of options that are put forward as alternatives to HFCs include hydrocarbons, hydrofluoroolefins (HFOs) and HFO/HFC blends. However, most options have trade-offs in terms of lower efficiency, lower capacity, or both; flammability and cost. For example, hydrocarbons are flammable and require specially trained operators, additional safety considerations, and even then are still limited by codes for commercial applications. HFO and HFO/HFC blends cost more than HFCs and are usually not able to match HFCs in efficiency and capacity. In addition, market adoption for these alternatives is predicted to be slow given the various hurdles for adoption.

While there is general consensus that there is a need to move towards alternatives with lower-GWP, there are many factors that point to HFCs still being the logical choice for the industry for the foreseeable future. HFCs remain widely used and available as they are low cost, efficient and safe. There is also a general understanding among industry experts that it is simply too soon and too risky to make a change to HFOs and other new refrigerants – as it may take a decade or more for these alternatives to be properly tested and approved by the relevant agencies and authorities.

In the meantime, any uncertainty that dealers, building owners and operators are experiencing – while understandable – is mostly unwarranted as governing bodies will continue to ensure that all parties concerned will be given ample time to make the shift when the time is ripe.

Already, global Heating, Ventilation And Air Conditioning (HVAC) manufacturers including Johnson Controls have taken steps to ensure that alternatives are in the pipeline, with the company reaffirming its commitment to investing US\$50 million towards the development and expansion of its low-GWP portfolio at a recent White House roundtable discussion on greenhouse gas emissions. As part of this initiative, Johnson Controls will also offer equipment that can be readily retrofitted with low-GWP options for customers concerned that they will not receive the full value over the entire life of their equipment, as well as develop aftermarket retrofit services for customers – who desire to convert their existing equipment to low-GWP refrigerants.

## HFCs Continue to Perform Best

Even as the search continues for comparable alternatives, widely used refrigerants such as R-134a and R-410A are still the products of choice as they represent the best balance of attributes of an optimal refrigerant.

For decades, Johnson Controls' selection of refrigerants have been guided by three sets of criteria that must



Johnson Controls' criteria for selection of refrigerant.

be considered before the selection of a particular refrigerant. These considerations have helped Johnson Controls serve and make the best decision for its customers at any given time.

## Safety and Reliability

There are many considerations when it comes to safety, chief of which includes the flammability and toxicity of the refrigerant. Commercial refrigerants that are entering the market, including newer HFC and HFO refrigerants, are flammable. Most safety standards and building codes do not allow flammable refrigerants in commercial applications. While codes and standards are currently being revised, the potential use of flammable refrigerants will require additional safety and ventilation solutions to mitigate risks – this adds to the installed cost of the system. In view of this, building standards and codes must also be updated to address these risks before flammable refrigerants can be used safely.

Restrictions on flammable refrigerants will also potentially restrict their penetration in commercial markets, especially in buildings with heavy foot traffic such as offices and schools. Added cost in the form of ventilation and other safety equipment, and costs for service technician, operator and other occupants, and increased liability will further hinder their penetration into the commercial market.

The toxic nature of some of these new refrigerants means that existing practices for handling these substances need to be improved. Technicians and personnel servicing HVAC and refrigeration systems will need to be re-trained and equipped with the proper tools to maintain these systems safely.

At the same time, reliability is key as incompatibility with HVAC system gaskets, elastomers, and materials of construction may result in refrigerants breaking down over time, impacting system performance and operating costs, or worse causing damage to the equipment. For these reasons, HFCs such as R-134a remain the refrigerant of choice having been tested extensively for safety and reliability across a wide range of systems and across different applications.

## Efficiency and Sustainability



*The YVAA Air-Cooled Variable Speed Drive Screw Chiller from YORK uses the widely available HFC-410A refrigerant.*

As with most industries time and experience is required to optimise a system based on a specific input, the HVAC industry is no different. A majority of the existing systems and equipment in use and available in the market have been optimised for refrigerants such as R-134a and R-410A, with no alternatives able to yet fully match their thermal efficiency and performance.

This is critical as chillers that utilise these new alternative refrigerants not optimised for these systems will likely exhibit lower efficiency,

resulting in higher operating and maintenance costs over time.

This leads us to a separate discussion on sustainability. While it is true that HFCs have higher GWPs than newer alternatives being offered, it is important to note that efficiency is essential to determining a chiller's environmental impact – as roughly 95 percent of a chiller's lifetime carbon footprint comes from indirect emissions. In simple terms, cooling less efficient chiller uses more energy; energy that is mostly produced by burning fossil fuels. As the additional electricity is usually generated by plants burning fossil fuel, this indirectly increases the amount of carbon dioxide emissions to the atmosphere.

The use of new refrigerants should consider the net carbon footprint, not just the GWP. To meet this goal, energy efficiency cannot, and should not, be sacrificed.

## Availability and Affordability

To be truly viable, alternative refrigerants must also be affordable. Many of the emerging refrigerants available today are more complex to manufacture and this is reflected in their prices, which can be up to 50 times more than existing fluids. While these costs will eventually decline and stabilise due to greater adoption, economies of scale from increased production and matured supply chains, these alternatives are still forecasted to cost several times more than current refrigerants such as the R-134a and R-410A.

This also brings to mind the question of availability given the limited quantities and release of new refrigerants in selected markets – something that building owners and operators should consider in their choice of equipment and refrigerants.

In the absence of updated codes and standards, it would be challenging to locate skilled personnel (trained and familiar with these refrigerants). All these inevitably point to increased operating costs over the lifecycle of the product, especially, if both the refrigerants and manpower remains limited in supply.

## HFCs - The Logical Choice

In conclusion, we are in the early stages of changes, and no industry can or will remain stagnant. However, HFCs continue to be the best choice of refrigerant for the foreseeable future for the lack of a comparable alternative.

While no refrigerant is perfect, HFCs currently provide us with the best balance of an optimal refrigerant: safety and reliability; efficiency and sustainability; and the availability and affordability that the industry needs. ■

**Brian S. Smith**

Director, Global Marketing  
Chiller Solutions Line of Business  
Johnson Controls



**Garry Chui**

Regional Manager, Chillers  
Asia Products and Distribution  
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# Recent Developments In Alternative Refrigerants

***The development of refrigeration and air conditioning industry depends to a large extent on the development of refrigerants to suit various applications and the development of various system components...***

Refrigeration and air conditioning provide a broad range of benefits to society, including the preservation of food, comfort conditioning of living spaces and workplaces, temperature and humidity control of different industrial processes. Refrigerants are the basic working fluids in refrigeration, air conditioning and heat pumping systems. They absorb heat from one area such as an air-conditioned space and reject it into another system such as outdoors usually through evaporation and condensation processes respectively.

The development of refrigeration and air conditioning industry depends to a large extent on the development of refrigerants to suit various applications – and the development of various system components. At present the industry is dominated by the vapour compression refrigeration systems, even though the vapour absorption refrigeration systems have also been developed commercially. The success of vapour compression refrigeration systems owes a lot to the development of suitable refrigerants. The theoretical thermodynamic efficiency of a vapour compression system depends mainly on the operating temperatures. However, important practical issues such as the system design, size, initial cost and operating cost, safety, reliability, and serviceability depend very much on the type of refrigerant and compressor selected for a particular application.

Throughout the history of air conditioning and refrigeration, numerous substances have been tried and used as refrigerants. However, choosing a refrigerant has become more complex in recent years. Earlier generation of refrigerants chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFCs) contributed to the depletion of stratospheric ozone and are being phased out under international treaty. CFCs and HCFCs largely have been replaced with hydrofluorocarbons (HFCs). Some of these HFCs have high global warming potentials (GWP) and are becoming subject to use restrictions in some countries as the world deals with global climate change. Recently, lower GWP HFCs (referred to as hydrofluoroolefins or HFOs) have been introduced. They have zero ozone depleting potential (ODP) and very low GWP, but some of them are mildly flammable and vast research is going on to overcome this problem as they are anticipated as next generation refrigerants.

The history and trend of refrigerant use for betterment of mankind so far can easily be understood from Fig.1.

Recently, global warming has been one of the most important issues facing mankind and in 1997, Kyoto protocol was proposed to control greenhouse gases including HFCs. MAC (Mobile Air Conditioning) directive specifically prohibits the use of fluorinated greenhouse gases whose GWP is greater than 150.

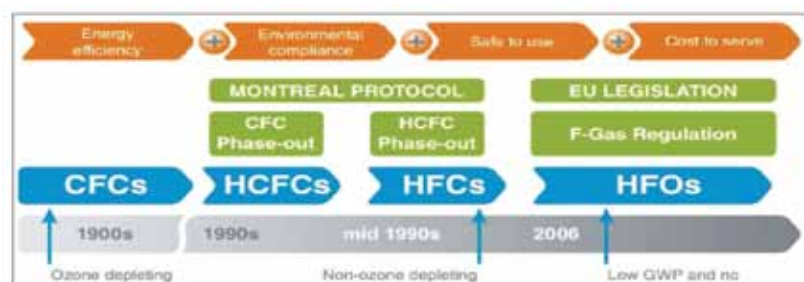


Fig1 Trend of refrigerants.

## Refrigerant Development

Historically the development of refrigerants can be divided into three distinct phases, namely:

- Refrigerants prior to the development of CFCs
- The synthetic fluorocarbon (FC) based refrigerants
- Refrigerants considering ODP and GWP

## Refrigerants prior to the development of CFCs

Water is one of the earliest substances to be used as a refrigerant, though not in a closed system. However, those natural refrigeration systems working with water have many limitations – and hence were confined to a small number of applications. William Cullen observed the production of low temperatures by evaporation of ethyl ether in 1748. Oliver Evans described a practical system that uses ethyl ether as the refrigerant in a closed cycle to produce ice from water. After these developments, ethyl ether was used as refrigerant for several years for ice making in breweries. Ethyl ether appeared to be a good refrigerant in the beginning, as it was easier to handle since it exists as a liquid at ordinary temperatures and atmospheric pressure. Ethyl ether has a normal boiling point (NBP) of 34.5 degree C, due to this, to have low temperatures than system will be operating under vacuum and operational vacuum can lead to air leakage into the system which may form explosive mixtures with ether. In addition to that ether is also toxic. So, as a result people have tried to develop new refrigerants which do not have these shortcomings.

In 1866, the American T.S.C. Lowe (1832-1913) introduced carbon dioxide as refrigerant. Carbon dioxide has excellent thermodynamic and thermo physical properties, however it has a low critical temperature (31.7 degree C) and very high operating pressures. Also, it is non-flammable and non-toxic. It was completely replaced by CFCs after sixty years of application. One of the landmark events in the history of refrigerants is the introduction of ammonia in 1872. Ammonia with a NBP of -33.3 degree C has excellent thermodynamic and thermo physical properties. However, ammonia is toxic and has a strong smell and slight flammability. In addition, it is not compatible with some of the common materials of construction such as copper. At present, ammonia is used in large refrigeration systems (both vapour compression and vapour absorption) and also in small absorption refrigerators.

In 1874, Raoul Pictet (1846-1929) introduced sulphur dioxide (NBP = -10.0 degree C). Sulphur dioxide was an important refrigerant and was widely used in small refrigeration systems such as domestic refrigerators due to its small refrigerating effect. Sulphur dioxide has the advantage of being an auto-lubricant. However, sulphur dioxide was subsequently replaced by CFCs.

## The synthetic fluorocarbon (FC) based refrigerants

Midgely and his colleagues developed a whole range of new refrigerants which are obtained by partial replacement of hydrogen atoms in hydrocarbons by fluorine and chlorine. They showed how fluorination and chlorination of hydrocarbons can be varied to obtain desired boiling points (volatility) and also how properties such as toxicity, flammability are influenced by the composition. The first commercial refrigerant to come out of Midgely's study was Freon-12 ( $\text{CCl}_2\text{F}_2$ ) in

1931. Freon-12 has a normal boiling point of -29 degree C and is one of the most popular synthetic refrigerants. It was exclusively used in small domestic refrigerators, air conditioners, water coolers etc for almost sixty years. Freon-11 ( $\text{CCl}_3\text{F}$ ) used in large centrifugal air conditioning systems was introduced in 1932. This is followed by Freon-22 ( $\text{CHClF}_2$ ) and a whole series of synthetic refrigerants to suit a wide variety of applications.

The introduction of CFCs and related compounds has revolutionized the field of refrigeration and air conditioning. Most of the problems associated with early refrigerants such as toxicity, flammability, and material incompatibility were eliminated completely. Freons enjoyed complete domination for about fifty years until the Ozone Layer Depletion issue was raised by Rowland and Molina in 1974. Rowland and Molina argued that the highly stable chlorofluorocarbons cause the depletion of stratospheric ozone layer. In view of the seriousness of the problem on global scale, several countries have agreed to ban the harmful Ozone Depleting Substances (CFCs and others) in a phase-wise manner under Montreal Protocol.

It is found that not all chlorofluorocarbons are equally capable of destroying the ozone layer. Figure 2 shows the ODP of different CFC and HCFC refrigerants. CFC -11 has been assigned ODP of value 1 and all other refrigerants have been rated against this reference. CFC and HCFC based refrigerants were also found to contribute significantly to global warming. Carbon dioxide has been given a global warming potential of 1. On this scale, it is observed that CFCs have global warming potential of several thousand as shown figures 3, 4, and 5. The refrigerants should be chosen keeping in mind the immediate personal safety issues such as flammability and toxicity as well as the long-term environmental issues such as ozone layer depletion and global warming.

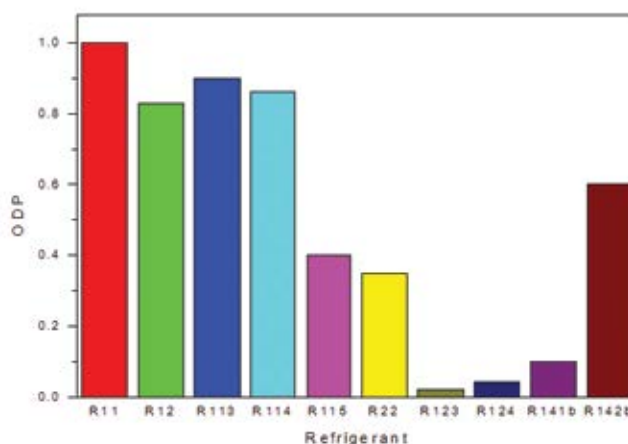


Fig.20 zone d p etion pt ential of p re CFC and H CFC refrigerants.

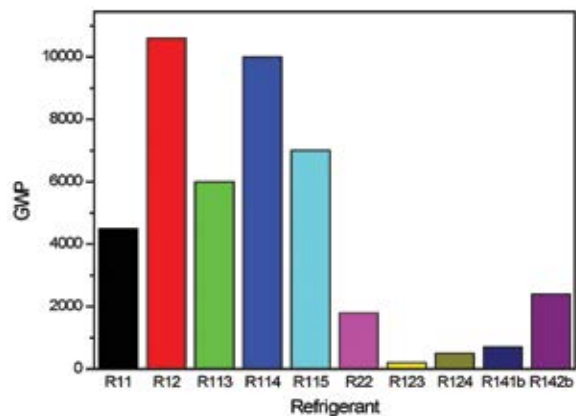


Fig.3*G* lobl warming of p re CFC andH CFC refrigerants.

Refrigerants considering ODP and GWP

The first step taken to encounter the ozone depletion was to introduce alternative refrigerants like hydrofluorocarbons (HFCs) and their mixtures. The reintroduction of natural refrigerants such as carbon dioxide (in a supercritical cycle), water, various hydrocarbons and their mixtures is expected to be a better solution. HFC-134a (synthetic substance) and hydrocarbons have emerged as alternatives to Freon-12. No clear pure fluid alternative has been found as yet for the other popular refrigerant HCFC-22. However several mixtures consisting of synthetic and natural refrigerants are being used and suggested for future use. In general, the non-ODP synthetic refrigerants such as HFC-134a have high global warming potential (GWP), hence they face an uncertain future.

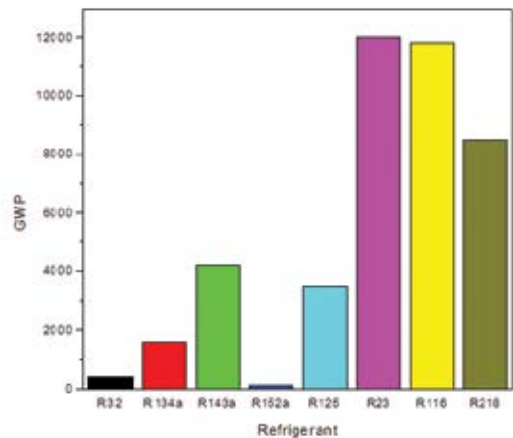


Fig.4*G* lobl warming of p re HFC refrigerants.

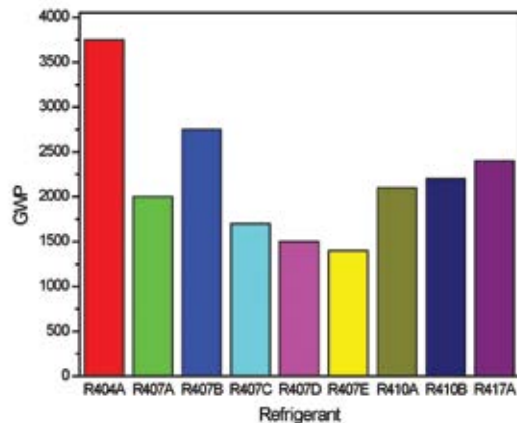


Fig.5*G* lobl warming of HFC mix ures refrigerant.

Most desirable properties of refrigerants

Careful selection of refrigerant has significant impacts on the safety, reliability and energy consumption of the system. A refrigerant must satisfy a number of requirements related to safety, chemical stability, environmental properties, thermodynamic characteristics and compatibility among materials.

**Thermodynamics properties:** The thermodynamic characteristics most importantly normal boiling point, critical temperature and heat capacity must match the application for the system to operate efficiently. The thermodynamic properties of some of the common refrigerants are listed in table 1.

Refrigerant	Molecular Mass (u)	Normal Boiling Temp(°C)	Critical Temperature (°C)	Critical Pressure (absolute) kPa
R-11	137.4	23.77	197.96	4,408
R-12	120.9	−29.8	111.97	4,136
R-22	86.5	−40.7	96.14	4,990
R-134a	102	−26.3	101.06	4,059
R-404A	97.6	-46.6/-45.8	72.14	3,735
R-409A	97.4	-35.4/-27.5	106.92	4,600
R-717	17.03	−33.34	132.4	11,280
R-744	44	−78	31.04	7,380
R-600a	58.1	−11.7	134.7	3,640

Tab e II hermo*d* namic p op rties of some common refrigerants.

**Chemical stability:** A refrigeration system is expected to operate many years, and all other properties would be meaningless if the refrigerant decomposes or reacts to form something else.

**Health and safety:** The ideal refrigerant should have low toxicity and be non-flammable at the same time should have zero ODP and lowest GWP.

**Thermo-physical properties:** Favourable transport properties like low viscosity and high thermal conductivity have an impact on the size of the heat exchangers, and thus cost of the overall system.

A final set of practical criteria relate to materials and impact the long-term reliability of a system.

The refrigerant must be compatible with common materials of construction, including metals and seals.

Possible and favourable next generation refrigerants

The alternative refrigerants have been categorized as transitional refrigerant or HCFC/HFC partly chlorinated refrigerants and into medium and long term refrigerants (Fig.6).

HCFC/HFC (partly chlorinated refrigerants) such as R22 and R134a are on the way to phase-out due to environmental concern.

Under medium and long term refrigerants like HFC chlorine free and their blend, low global warming potential (GWP) refrigerant (R1234yf,1234ze) and halogen free refrigerant (natural refrigerant) are at present looking as the viable options for future refrigerant.



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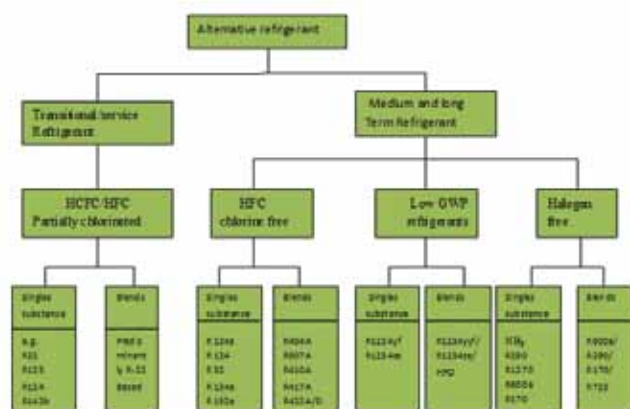


Fig. 6- Classification of Alternative Refrigerant

Fig. 6- Classification of alternative refrigerants...

## Low global warming refrigerant

### HFO (Hydrofluoroolefin)

Hydrofluoroolefins (HFOs) are a family of unique compounds compared to the compounds previously developed for commercial use for heat transfer, blowing agent, solvent and propellant applications. After extensive research and development some members of this family have been found to offer comparable performance to today's most widely used refrigerants.

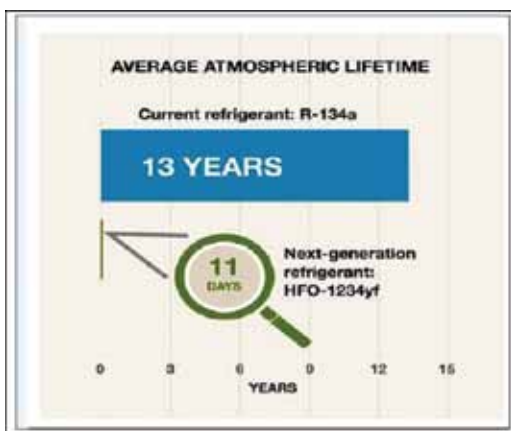


Fig. 7. Life cycle of refrigerant...

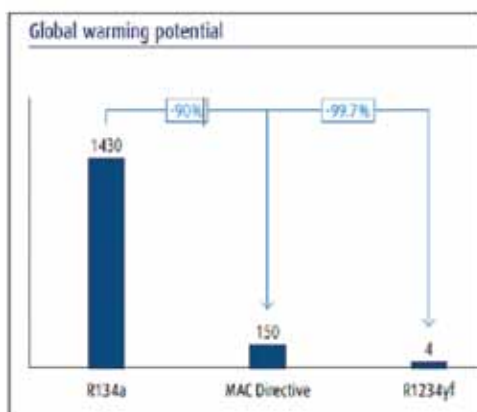


Fig. 8. GWP of refrigerant R1234yf...

These products have short atmospheric lifetimes and have very low global warming potential with respect to R134a as shown in Fig.7 and Fig.8 respectively.

Recently, R1234yf (2,3,3,3-Tetrafluoropropene) having chemical formula  $\text{CH}_2=\text{CFCF}_3$  has been proposed as a possible alternative refrigerant for HFC134a. R1234yf has zero ODP and excellent life cycle climate performance (LCCP) as compared to HFC134a. HFO-1234yf has the lowest switching cost for automakers among the currently proposed alternatives, although the initial cost of the product is much higher than that of R-134a.

Another HFO based refrigerant HFO 1234ze (trans-1,3,3,3-Tetrafluoroprop-1-ene,  $\text{CF}_3\text{CH}=\text{CHF}$ ) is an energy-efficient alternative to traditional refrigerants in air-cooled and water-cooled chillers for supermarkets and commercial buildings, as well as in other medium temperature applications such as heat pumps, refrigerators and  $\text{CO}_2$  cascade systems in commercial refrigeration. Refrigerant HFO-1234ze is the best medium pressure, zero ODP and low GWP refrigerant on the market when considering the balance of all properties. A unique characteristic of this refrigerant is the absence of flammable mixture with air under  $30^\circ\text{C}$  of ambience.

R-449A is a non-ODP, lower GWP hydrofluoro-olefin (HFO) based refrigerant replacement for R-404A/R-507, R-407A/F and R-22. R449A is designed for use in positive displacement direct expansion low and medium temperature commercial and industrial applications. It has a GWP of 1397, which is a 65% reduction and provides energy consumption 8-12% lower than R-404A/R-507. R-449A is presently the best choice to replace 404A for stationary refrigeration systems.

Refrigerants R-513A, DR-55, R-452A are non-ODP, low GWP HFO based refrigerants. R-513A is developed to replace R-134a in positive displacement, direct expansion, medium-temperature commercial and industrial, including centrifugal chillers. DR-55 will be the leading low GWP replacement for R-410A as it is easily convertible from R-410A designs while offering the optimal balance of energy performance.

### HFC/HCFC blend

R-407F is a non-ODP replacement for R-22 and lower GWP (1825) replacement for R404A in various air-conditioning applications particularly in low-temperature applications. Since it is a close match to R-22, it also serves as a retrofit fluid in applications where R-22 is used. R-407F contains HFC-32, HFC-125, HFC-134a. R-409A (a HCFC blend) containing HCFC-22 (60%), HCFC-124 (25%), HCFC-142b (15%) is an interim replacement for R-12 in stationary positive displacement air-conditioning and refrigeration systems such as walk-in coolers, beverage dispensers and supermarket systems. Its ODP is 0.046 and GWP is 1909. R-401B may act as an interim replacement for R-12 in low-temperature commercial refrigeration systems, for transport refrigeration, low temperature retrofits, retrofits including air conditioners and dehumidifiers. It is made up of HCFC-22 (61%), HFC-152a (11%), HCFC-124 (28%). The ODP and GWP values for this mixed refrigerant are 0.036 and 1288 respectively. R-422D is a non-ozone depleting replacement for R-22 in low- and medium-temperature commercial refrigeration systems suitable for direct expansion evaporators. It contains HFC-125 (65.1%), HFC-134a (31.5%), HC-600a (3.4%) and has a GWP of 2729.

It is now clear that HCFC/HCFC blends are good refrigerants considering ODP, but at same time they are having somewhat more GWP compared to what expected from future refrigerants ( $\text{GWP} < 150$ ). Obviously, they are not



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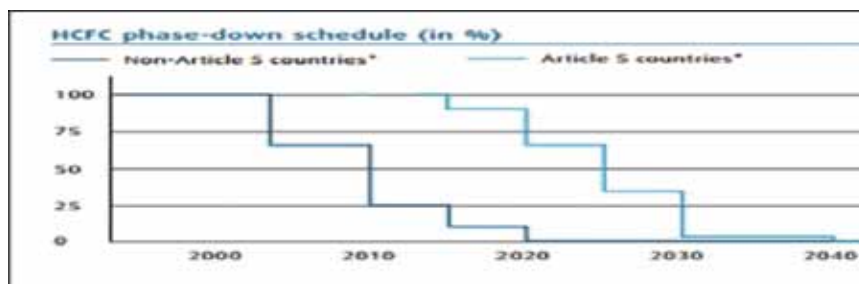


Fig.9H HCFC phase down schedule in (%).

viable option for future and already the phase down has been started in several developed countries (termed as non-article country in Fig. 9) under Kyoto protocol.

### Natural refrigerant

Natural refrigerants are now reconsidered for future refrigerants for different applications (which have been shown in Fig. 10) after the restriction imposed on the ODP and GWP values of refrigerants through international protocol. Ammonia (R717) has been used in industrial applications since the 1930s and is generally acknowledged as being the most efficient refrigerant. It has minimal environmental impact having zero ODP and zero GWP. It is anticipated that use of ammonia for large-scale air conditioning systems will continue to increase. Ammonia installations, however, tend to be relatively expensive due to the requirement for steel tubing, semi hermetic compressors and the installation of a number of safety devices, such as gas detectors. Carbon dioxide (R744) has been used as a refrigerant since 1862 despite the high pressures associated with it. Carbon dioxide is continuing as refrigerant in marine refrigeration as a non-toxic alternative to ammonia and methyl chloride. As a result of modern methods and developments, carbon dioxide is coming back into use as a refrigerant in systems, which have efficiencies at least as great as the efficiencies of halocarbon and ammonia systems. Carbon dioxide can be used as the low temperature refrigerant in carbon dioxide/ammonia cascade systems, as a volatile secondary refrigerant and also as a direct refrigerant. From an environmental perspective  $\text{CO}_2$  is a very attractive refrigerant with zero ODP and a GWP of 1. Some researchers believe that  $\text{CO}_2$  will be the main refrigerant in multipack commercial refrigeration systems.

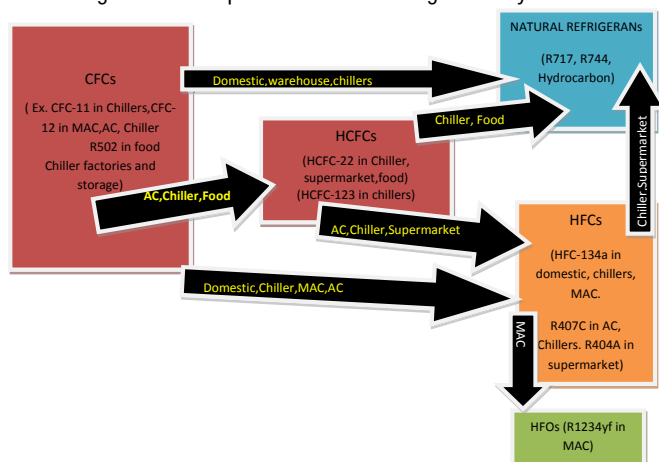


Fig.10 Different roots of refrigerant development.

### Hydrocarbons

Hydrocarbons are excellent refrigerants in practice provided precautions are taken against their high flammability. They are miscible with mineral oils and have relatively high critical temperatures. Propane (R290) and propylene (R1270) have normal boiling points below  $-40^\circ\text{C}$  and are therefore suitable for general refrigeration applications. Butane (R600) and isobutene (R600a) have much higher boiling points but they also have high critical temperatures, which tends to make them very efficient in operation.

Isobutene (R600a) was introduced in household appliances in some parts of the world from the start of CFC phase out. Over 50 million such refrigerators have been produced. R170 (Ethane) is a natural refrigerant suitable for use in very low temperature refrigeration applications. It is non-toxic with zero ODP and very low GWP of 6. Propane (R290) was introduced later and replaced R134a, R22 or R404A in some appliances. The use of R290 is increasing due to its low environmental impact (zero ODP and GWP of 3) and excellent thermodynamic performance.

### Conclusions

From last few decades vast research on new environment friendly alternative refrigerant is going on. Initially refrigerants based on HCFC/HFC blends were tried as short term solution. More recently, natural refrigerants are being reconsidered. However, the most promising finding is the use of HFOs based refrigerant like R1234yf, R1234ze. These refrigerants have the potential to replace R134a and R22 respectively. Industries are preferring HFO refrigerants over natural refrigerant as the most efficient refrigerant. On the other hand natural refrigerant has greater chances to come on limelight in near future as best possible alternative.

Use of ammonia will continue, especially for larger industrial systems and for larger air conditioning systems. After an absence of 50 years, carbon dioxide has returned to the field of refrigeration and its use is increasing rapidly. Hydrocarbons would not appear attractive for large-scale air conditioning applications but they will certainly appear as a refrigerant for window air conditioners of low charge. The use of low environmental impact refrigerants like the natural refrigerants (R290, R1270 and R744) and HC/HFC refrigerants in air conditioning and heat pump applications play a vital role in the developing countries like India for reducing the environmental impact of halogenated refrigerants. ■

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# Your Ideas Help Make The World A Better Place

## Congratulations to The Emerson Cup Winners!

It was yet another triumph for creativity, the spirit of innovation and the quest for a greener world, at the Eighth edition of The Emerson Cup. Incredible designs and products were showcased, cheers and plaudits were garnered, and a new set of benchmarks were created for the industry.

Emerson congratulates all the winners of The Emerson Cup and reiterates its commitment to champion the cause of innovative, eco friendly air conditioning and refrigeration projects and products that promote sustainability.

Emerson is truly grateful to all who have contributed and played a part in making The Emerson Cup a grand success.

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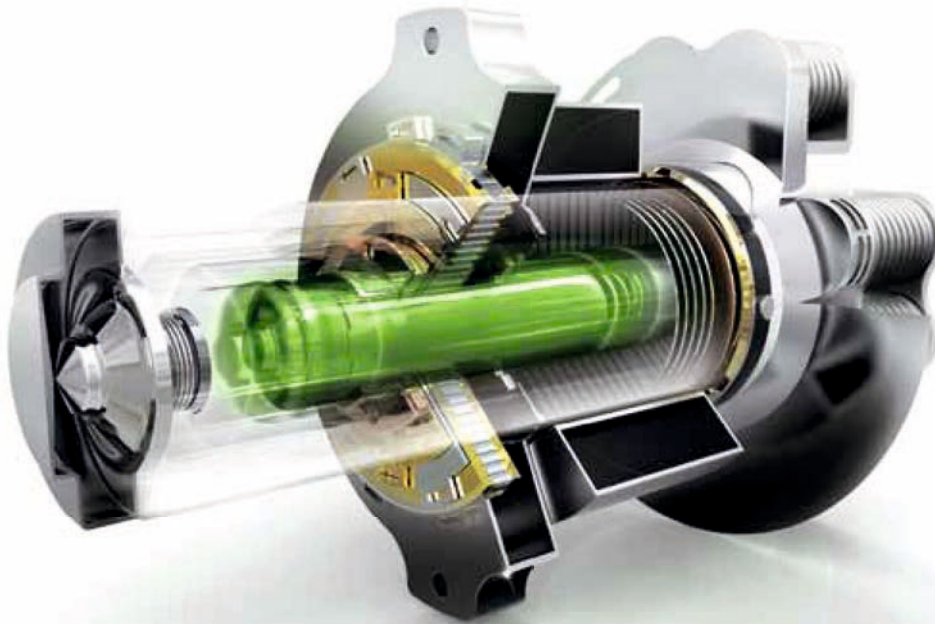
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# Benefits Of Using Inverter Compressors



***In recent years, compressors with variable speed drives have gained an increased market share in air conditioners and household refrigerators, due to improved efficiency and reliability brought about by advancements in material and manufacturing technology and optimised design...***

This article presents a review of the application of variable speed capacity control to refrigeration systems. The aim is to put together diversified information in a single source and to appraise recent advances in variable speed technology. The review reveals that variable speed drives based on inverters have been applied successfully to control the capacity of positive displacement machines such as compressors. Inverter-based variable speed compressor technology offers the potential for energy savings.

The compressor is the 'heart' of any Refrigerator or Air Conditioner and most of the research revolves around the compressor to make it more efficient to improve overall performance of these two types of products.

Technology changes on a daily basis and inverter compressor have started replacing conventional compressors in appliances like Refrigerators and Air Conditioners.

The inefficient use of electricity to drive the compressors of refrigeration and air-conditioning systems is considered as an indirect contributor to the emission of greenhouse gases to the atmosphere. This emission can be reduced by improving the energy conversion efficiency

of refrigeration systems. One of the methods of achieving this is through capacity control, which matches the system capacity to the load. Capacity control reduces the on/off cycling losses of the equipment and improves the steady-state efficiency of an appliance due to a lower pressure differential across the compressor at part-load conditions.

The basics of Conventional versus Inverter Compressors will be discussed one by one in the following paragraphs.

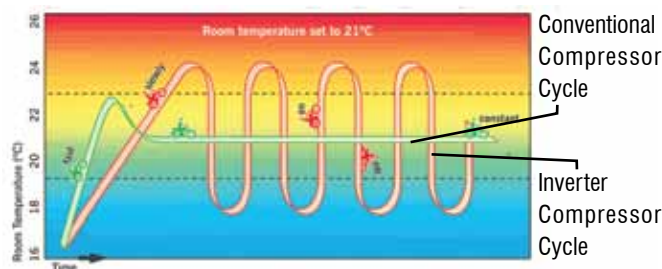
## **Working of conventional compressor**

The Conventional Compressor works on a principle of 'Single Speed.' They are either 'ON' or 'OFF' based on the loading or temperature setting of a thermostat in a refrigerator or air conditioner. Here, most compressors are designed to handle the peak load condition (e.g., high temperature in summer), which indicates they will run in peak load even if the ambient temperature is less during the winters.

This ultimately results in high power consumption and with the user paying a high electricity bill. Moreover, conventional compressors are designed to take care of heat ingress due to the frequent door openings and closings for refrigerator or to the outdoors for air conditioners.



## Working of inverter compressor



Unlike the Conventional Compressor here the Inverter Compressor works on a principle of 'Variable Frequency Drive' to cause the speed of the compressor to vary as a result of varying load conditions. The change in speed of the compressor, in turn, causes the refrigerant flow to change.

The Inverter technology is the latest evolution of technology concerning the compressor motor. An Inverter is used to control the speed of the compressor motor, so as to continuously regulate the temperature. The Inverter units have a variable-frequency drive that comprises an adjustable electrical inverter to control the speed of the compressor motor, which in turn adjusts the compressor output.

The drive converts the incoming alternating power (AC) source to direct current power, and then through a modulation in an electrical inverter produces current of desired frequency. A microcontroller samples the ambient air temperature and adjusts the speed of the compressor accordingly.

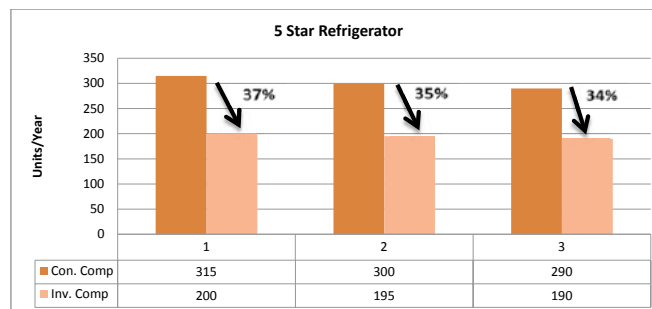
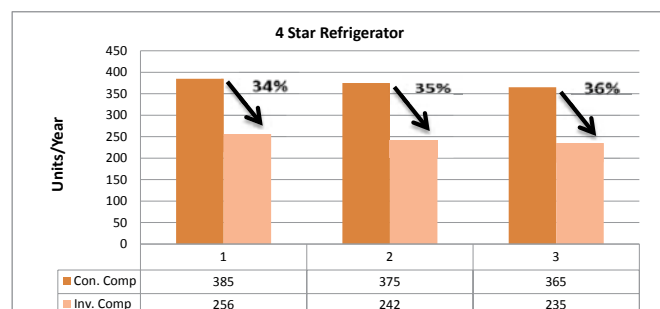
A compressor with inverter technology helps ensure that during summer months when cooling load is high, the compressor works at high capacity. At other times when cooling load is less, the compressor works at a lower capacity setting.

Gross Capacity (Liters)	Energy consumption (kWh/year)				Energy Saved (%)	
	Conventional Compressor		Inverter Compressor			
	4 star	5 star	4 star	5 star #	4 star	5 star
310	385	315	256	200	34	37
285	375	300	242	195	35	35
258	365	290	235	190	36	34

## Comparative data between conventional & inverter compressor

### Refrigerator

Have a look at the few of the actual tested data of 4 Star & 5 Star



Refrigerators of various Gross Capacity for their energy consumption:

It is clearly seen that inverter compressor is consuming less power compared to the conventional compressor in a range of 34 to 37%, which is a very high percentage.

**Note:** Few Refrigerators were tested at UL Manesar Lab and based on result percentage saving calculated and highlighted. Additionally for outcome compressor is not the only factor, refrigerant used too are different. Refrigerant (134 a) was used in a conventional compressor while (600-a) was used in inverter compressor.

## Advantages of inverter compressors

Inverter compressor technology is highly responsive and efficient. Moreover, it is compact and quite unit that allows flexibility of placement. The inverter air conditioning units have increased efficiency when compared to traditional air conditioners. Also, sharp fluctuations in the load are eliminated. This makes the inverter units quieter, with lower operating cost and more reliable. The inverter units are more expensive than the constant speed air conditioners, but this initial expense can be offset by lower energy bills.

## Conclusions

The article is entirely focused on the 'Consumers of India' and to spread the awareness for the better energy efficient product available in market while purchasing and at the same time enabling each of us to save the energy and contribute in 'India's Growth Story.'

In recent years, compressors with variable speed drives have gained an increased market share in air conditioners and household refrigerators, due to improved efficiency and reliability brought about by advancements in material and manufacturing technology and optimised design.

Over the past few years, the price of inverters has been steadily decreasing. This trend is attributed generally to improved design, increased production and the decrease in the price of electronic devices.

The reliability of inverters is also constantly improving, due to improved technology and the availability of better components. Space requirements are also decreasing, due to improved packaging, higher efficiency, more effective heat sinks and improved circuitry. ■

**Manish Surendra Surti**  
Lead Engineer  
UL (Underwriter Laboratories), India

# Historic Paris Agreement On Climate Change

***The universal agreement's main aim is to keep a global temperature rise this century well below 2 degrees Celsius and to drive efforts to limit the temperature increase even further to 1.5 degrees Celsius above pre-industrial levels...***

A historic agreement to combat climate change and unleash actions and investment towards a low carbon, resilient and sustainable future was agreed by 195 nations in Paris on 12<sup>th</sup> December. The Paris Agreement for the first time brings all nations into a common cause based on their historic, current and future responsibilities.

The universal agreement's main aim is to keep a global temperature rise this century well below 2 degrees Celsius and to drive efforts to limit the temperature increase even further to 1.5 degrees Celsius above pre-industrial levels. The 1.5 degree Celsius limit is a significantly safer defence line against the worst impacts of a changing climate.

Additionally, the agreement aims to strengthen the ability to deal with the impacts of climate change. To reach these ambitious and important goals, appropriate financial flows will be put in place, thus making stronger action by developing countries and the most vulnerable possible, in line with their own national objectives.

"The Paris Agreement allows each delegation and group of countries to go back home with their heads held high. Our collective effort is worth more than the sum of our

individual effort. Our responsibility to history is immense," said Laurent Fabius, President of the COP 21 UN Climate change conference and French Foreign Minister. The minister, his emotion showing as delegates started to rise to their feet, brought the final gavel down on the agreement to open and sustained acclamation across the plenary hall.

French President Francois Hollande told the assembled delegates, "You've done it, reached an ambitious agreement, a binding agreement, a universal agreement. Never will I be able to express more gratitude to a conference. You can be proud to stand before your children and grandchildren."

UN Secretary General Ban Ki-moon said, "We have entered a new era of global cooperation on one of the most complex issues ever to confront humanity. For the first time, every country in the world has pledged to curb emissions, strengthen resilience and join in common cause to take common climate action. This is a resounding success for multilateralism."

Christiana Figueres, Executive Secretary of the UN Framework Convention on Climate Change (UNFCCC), said, "One planet, one chance to get it right and we did it in Paris. We

have made history together. It is an agreement of conviction. It is an agreement of solidarity with the most vulnerable. It is an agreement of long-term vision, for we have to turn this agreement into an engine of safe growth."

"Successive generations will, I am sure, mark the 12<sup>th</sup> December 2015 as a date when cooperation, vision, responsibility, a shared humanity and a care for our world took centre stage," she said.

"I would like to acknowledge the determination, diplomacy and effort that the Government of France have injected into this remarkable moment and the governments that have supported our shared ambition since COP 17 in Durban, South Africa," she said.

## Agreement captures essential elements to drive action forward

The Paris Agreement and the outcomes of the UN climate conference (COP21) cover all the crucial areas identified as essential for a landmark conclusion:

- Mitigation - reducing emissions fast enough to achieve the temperature goal
- A transparency system and global stock-take - accounting for climate action
- Adaptation - strengthening ability of

UN Photo/Mark Garten



**UNFCCC's Christiana Figueres (left); UN Secretary-General Ban Ki-moon (2<sup>nd</sup> left); French Foreign Minister Laurent Fabius and President of the UN Climate Change Conference in Paris (COP21); and President Franois Hollande of France (right), celebrate historic adoption of Paris Agreement.**

countries to deal with climate impacts

- Loss and damage - strengthening ability to recover from climate impacts
- Support - including finance, for nations to build clean, resilient futures.

As well as setting a long-term direction, countries will peak their emissions as soon as possible and continue to submit national climate action plans that detail their future objectives to address climate change.

This builds on the momentum of the unprecedented effort, which has so far seen 188 countries contribute climate action plans to the new agreement, which will dramatically slow the pace of global greenhouse gas emissions.

The new agreement also establishes the principle that future national plans will be no less ambitious than existing ones, which means these 188 climate action plans provide a firm floor and foundation for higher ambition.

Countries will submit updated climate plans – called Nationally Determined Contributions (NDCs) – every five years, thereby steadily increasing their ambition in the long-term.

Climate action will also be taken forward in the period before 2020. Countries will continue to engage in a process on mitigation opportunities and will put added focus on adaptation opportunities. Additionally, they will work to define a clear roadmap on ratcheting up climate finance to USD 100 billion by 2020.

This is further underlined by the agreement's robust transparency and accounting system, which will provide clarity on countries' implementation efforts, with flexibility for countries' differing capabilities.

"The Paris Agreement also sends a powerful signal to the many thousands of cities, regions, businesses and citizens across the world already committed to climate action that their vision of a low-carbon, resilient future is now the chosen course for humanity this century," said Figueres.

### Agreement strengthens support to developing nations

The Paris Agreement underwrites adequate support to developing nations and establishes a global goal to significantly strengthen adaptation to climate change through support and international cooperation.

The already broad and ambitious efforts of developing countries to build their own clean, climate-resilient futures will be supported by scaled-up finance from developed countries and voluntary contributions from other countries.

Governments decided that they will work to define a clear roadmap on ratcheting up climate finance to USD 100 billion by 2020,

while also before 2025 setting a new goal on the provision of finance from the USD 100 billion floor.

Figueres said, "We have seen unparalleled announcements of financial support for both mitigation and adaptation from a multitude of sources both before and during the COP. Under the Paris Agreement, the provision of finance from multiple sources will clearly be taken to a new level, which is of critical importance to the most vulnerable."

International cooperation on climate-safe technologies and building capacity in the developing world to address climate change are also significantly strengthened under the new agreement.

### Signing the Paris Agreement

Following the adoption of the Paris Agreement by the COP (Conference of the Parties), it will be deposited at the UN in New York and be opened for one year for signature on 22<sup>nd</sup> April 2016 – Mother Earth Day.

The agreement will enter into force after 55 countries that account for at least 55% of

**Following the adoption of the Paris Agreement by the COP (Conference of the Parties), it will be deposited at the UN in New York and be opened for one year for signature on 2<sup>nd</sup> April – Mother Earth Day.**

global emissions have deposited their instruments of ratification.

### Cities and provinces to companies and investors aligning

Today's landmark agreement was reached against the backdrop of a remarkable groundswell of climate action by cities and regions, business and civil society.

During the week of events under the Lima to Paris Action Agenda (LPAA) at the COP, the groundswell of action by these stakeholders successfully demonstrated the powerful and irreversible course of existing climate action.

Countries at COP 21 recognised the enormous importance of these initiatives, calling for the continuation and scaling up



of these actions, which are entered on the UN-hosted NAZCA portal as an essential part in the rapid implementation of the Paris Agreement.

The LPAA and NAZCA have already captured climate actions and pledges covering:

- Over 7,000 cities, including the most vulnerable to climate change, from over 100 countries with a combined population with one and a quarter billion people and around 32% of global GDP
- Sub-national states and regions comprising one fifth of total global land area and combined GDP of \$12.5 trillion
- Over 5,000 companies from more than 90 countries that together represent the majority of global market capitalisation and over \$38 trillion in revenue
- Nearly 500 investors with total assets under management of over \$25 trillion
- Christiana Figueres said, "The recognition of actions by businesses, investors, cities and regions is one of the key outcomes of COP 21. Together with the LPAA, the groundswell of action shows that the world

is on an inevitable path toward a properly sustainable, low-carbon world."

### More details on the Paris Agreement

- All countries will submit adaptation communications, in which they may detail their adaptation priorities, support needs and plans. Developing countries will receive increased support for adaptation actions and the adequacy of this support will be assessed
- The existing Warsaw International Mechanism on Loss and Damage will be significantly strengthened
- The agreement includes a robust transparency framework for both action and support. The framework will provide clarity on countries' mitigation and adaptation actions, as well as the provision of support. At the same time, it recognises that Least Developed Countries and Small

Island Developing States have special circumstances

- The agreement includes a global stocktake starting in 2023 to assess the collective progress towards the goals of the agreement. The stocktake will be done every five years
- The agreement includes a compliance mechanism, overseen by a committee of experts that operates in a non-punitive way
- The COP also closed on a number of technical issues
- Under the Kyoto Protocol, there is now a clear and transparent accounting method for carry-over credits for the second commitment period, creating a clear set of rules
- The first round of international assessment and review process (IAR) that was launched in 2014 was successfully completed
- A number of technical and implementation issues related to the existing arrangements on technology, adaptation, action for climate empowerment and capacity building were also successfully concluded. ■

## Testo Precision Drive: Now At Your Doorstep

**T**esto India is proud to announce the launch of 'Testo Precision Drive' – a showroom on wheels. The roadshow will allow the customers to interact with our specialists and learn more about Testo products and their applications in their respective industries with hands on experience of the products.

In a country like India, everyone wants to physically see and experience the features and benefits of a product before making a purchase decision; the same rule is also applicable when it comes to industrial products. To bridge this gap between the customer and the manufacturer in the industrial products' sector, Testo India has launched an initiative the 'Testo Precision Drive' - a mobile exhibition to bring our entire product range to our customer at their doorstep. This mobile exhibition will provide a platform for the existing and potential customers to interact with our specialists to gain more knowledge about our products and their applications, that too at their doorsteps. This exhibition on wheels travelled across all the states in the Southern India over a period of 6 months to explore deeper pockets of the industrial hubs present in all these states starting 22<sup>nd</sup> December 2015 in Karnataka at the Bommasandra Industrial Area.

Kalidas Bhangare, MD, Testo India inaugurated the mobile exhibition 'Testo Precision Drive.' It also registered the presence of Testo India customers who became a part of the flag-off ceremony and appreciated the initiative. During this journey, in places where there are cluster of industries around, the showroom was centrally parked, so that customers from all the surrounding industries could have accessed and visited the Testo lounge. In addition, for all those corporations who permitted the lounge to be taken inside their premises, Testo showroom was moved into their peripherals for all their various functions to have a look at the Testo product basket. ■



**For further information contact:** [www.testo.in](http://www.testo.in)

# Fully Automated Frick India Rotary Twin Screw Compressor Packages for all Refrigeration Solutions



**Capacity Range :**  
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Refrigerant : R-717

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## FEATURES :

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Frick India offers fully automated PLC controlled Refrigeration plant using VFD's. VFD maintain the suction pressure constant by continuously adapting the speed of the compressors. the main advantages are :

1. Improved cooling quality by maintaining a constant suction pressure.
2. wider range of operation of refrigeration power.
3. Increase power by increasing the speed of the compressor.
4. Energy Saving
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**You Still can't beat the System when it's all FRICK INDIA**



# ODYSSEY OF

# REFRIGERATION

***The late 80's & early 90's saw the plans for phasing out of CFCs in the developed countries. Montreal Protocol was signed, where India was also as a signatory. Sadly, it permitted the developing countries to phase out the CFCs by the middle of this century. The largest population of the planet was thus permitted to use CFCs for a long time. India, China and other developing countries took upon themselves to phase out the CFCs...***

Man has known from the ancient times, how to preserve the produce harvested in the season, for usage year-round. This was primarily done by storing under-ground and ensuring zero exposure of sunlight or air to the harvested products. The art of preserving dairy products flourished in the colder countries, using snow, which came from the sky through the winter months. Man also learnt to keep snow for longer period by letting it freeze to ice, then wrapping ice in bags made of jute, saw-dust, straw and rice husk.

Then came the ice famine in 1890's when it did not snow all through the winter. It was apparently a prelude to the global warming that we are experiencing today. The demand of ice for South American consumers, enjoying ice from North America & Canada, had to be met. Therefore, search for Mechanical Refrigeration began.

European scientists had already developed scientific method of vapour compression to convert water into ice. Their laboratory experiments were exploited for commercial usage by American entrepreneurs for shipping ice to South America. It is interesting to note that the unit of refrigeration was defined as follows:

"1 ton of refrigeration (1 TR) = amount of cooling required to maintain 1 ton (American ton of 2000 LBS) of ice as ice in its 24 hour journey to South America. The latent heat of

fusion of ice is 144 British Thermal Units (BTU) per LB of ice. Thus,  $1 \text{ TR} = (2000 \text{ LBS of ice} \times 144 \text{ BTU/LB}) \div 24 \text{ hrs} = 12,000 \text{ BTU/hr}$ ". The unit is used even today, for rating the cooling capacity of air-conditioning equipment.

Man made ice was thus introduced for the first time in the late 1890's. This led to domestic refrigerators for the super-rich. You can imagine a party being held in the luxurious home of a Rockefeller or a Kennedy, where the domestic refrigerator was given the pride of place in the centre of the living room, for dispensing ice and ice-creams. The problem was that refrigerants used were highly toxic, namely - Ammonia, Sulphur Dioxide, Nitrous Oxide and others. If the refrigerator was detected to have a leak, the party had to be called off, or moved outdoors, losing its sheen. The first ever refrigerator can still be seen at the Smithsonian Museum along with Wright's Kitty Hawk, which allowed man to fly.

The major breakthrough for the refrigerants came in 1930s when four young Norwegians, with their fresh PhDs in Chemical Engineering, were assigned, by General Motors and DuPont to develop a non-toxic refrigerant. A long wish list was given to them for the desired properties of the refrigerant.

It is simply incredible that what had eluded man for decades, got zeroed-in by these four young brilliant engineers within a few weeks.



They chose four elements out of the entire list of elements; namely - chlorine, fluorine, hydrogen and carbon, for the formulation of the ideal refrigerant. Thus, in the early 30's dichloro-difluoro-methane came into existence. It fulfilled almost the entire wish-list that was given to the scientists. Thirties were the years of the great depression in America, and the second larger batch being tried on guinea-pigs & rats failed due to spurious chlorine being used. Unfortunately for human history, the spurious chlorine got detected and isolated. Thus, first CFC was proclaimed for use in refrigeration, changing the entire face of refrigeration industry, superseding all natural refrigerants.

Within a few years, the World War II came, and it was discovered that CFC could be effectively used in aerosol bombs. Therefore, the warring countries got busy, through the early 1940's, shelling cities across Europe, using bombs filled with CFCs. Only when the war ended, the CFCs went back to the refrigeration industry.

The 50s & 60s saw excessive use of CFCs as Panacea for all human wants – like spray can for perfumes, spray cans for toiletries like shaving foam, inflating of leaking automobile tyres, coating of cooking utensils, and for a whole host of consumable durables.

First warning sign of the environmental damage by CFCs came in the early 1970's

when scientists discovered a huge hole in Ozone layer in the outer parts of the earth's atmosphere. This had resulted into excessive skin cancer amongst the most affluent society in the western part of the USA. Alarm bells were sounded and the culprit was diagnosed to be the chlorine in the CFC. The damage to the Ozone layer was permitting the severely damaging ultraviolet rays of the Sun, to travel unchecked to the occupants on the planet.

The late 80's & early 90's saw the plans for phasing out of CFCs in the developed countries. Montreal Protocol was signed, where India was also as a signatory. Sadly, it permitted the developing countries to phase out the CFCs by the middle of this century. The largest population of the planet was thus permitted to use CFCs for a long time. India, China and other developing countries took upon themselves to phase out the CFCs, and align with the countries willing to provide alternate refrigerants, at affordable prices.

It is heartening that countries in Europe and Japan are developing various refrigerants with low or no Ozone Depletion Potential (ODP) and low or no Global Warming Potential (GWP). These refrigerants are eliminating the CFCs, HCFCs and HFCs from European and Japanese markets. Some of these are now being manufactured in India, and we hope the refrigeration industry will soon adopt

refrigerants with zero ODP and low GWP, which are becoming commercially viable.

Europe is also moving in a brisk way with the revival of natural refrigerants like Ammonia, with necessary safeties built-in to avoid exposure of humans to the toxic elements of these natural refrigerants.

National Building Code of India has released Addendum I to NBC 2005, titled 'Approach to Sustainability.' It contains a Chapter, exclusively dedicated to refrigerants. This will now become part of the Chapter 11 of the new NBC 2015, scheduled to be released early next year. More information can be obtained from the Bureau of Indian Standards (website: [www.bis.org.in](http://www.bis.org.in)).

The Indian Society of Heating Refrigerating & Air-conditioning Engineers (ISHRAE) has recently published 'ISHRAE Position Document on Refrigerants,' dated December 2015. It is a scholarly compilation, exhorting Indian HVAC&R Industry to keep pace with the rapidly changing scenario in the field of refrigerants. More information can be obtained from ISHRAE Headquarters, by writing to [info@ishraehq.in](mailto:info@ishraehq.in). ■

**Dr Prem C Jain**  
Chairman IGBC  
President Emeritus ISHRAE





# Shipping Company Selects Alfa Laval's Product

**T**oday, Alfa Laval is a well known name within the key technology areas of heat transfer, separation and fluid handling. The company was founded on a single brilliant invention, and innovation remains at the heart of everything that they do. With more than 2000 patents, they provide worldwide solutions in areas that are vital to society.

Headquartered in Hamburg, Germany, Buss Shipping, the shipping arm of the worldwide maritime logistics service provider Buss Group, is a container ship operator with 20 feeder ships and a strong chartering business. To meet the requirements of today's charter market, the company is focusing on the sustainable modernisation of its existing fleet.

Buss Shipping will soon install Alfa Laval PureSOx exhaust gas cleaning systems on two of its container vessels. The SOx scrubbers will secure valuable fuel economy in a competitive charter market. As a key step in this process, hybrid Alfa Laval PureSOx systems will be retrofitted on board the vessels Condor and Corsar. Both are container feeders of 1025 TEU that operate exclusively in Emission Control Areas (ECAs).

Since they frequent the low-alkalinity waters between Rotterdam and St. Petersburg, as well as ports like Hamburg with zero-discharge requirements, a scrubber with closed-loop mode was a necessity.

"The hybrid PureSOx systems on the Condor and Corsar will provide emission compliance with maximum flexibility and fuel economy. This will uphold the competitiveness of our offer to charter customers," says Torben Kölln, Managing Director, Buss Shipping.

The Condor and Corsar will each receive a hybrid PureSOx system with multiple inlets, connecting the main engine and two

auxiliary engines to one U-design scrubber. In contrast to earlier systems with multiple inlets, the inlets will now lead into a single scrubber jet section – an advance in construction that will make the scrubber even more compact.

"The PureSOx solution was well engineered and allowed a sophisticated integration of the scrubber system into our container feederships. The custom construction let us avoid major modifications inside the vessel, which together with the pre-outfitting gave us a short installation time. All those factors contributed to a competitive price," says Christoph Meier, Project Manager, Buss Shipping.

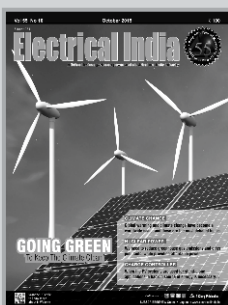
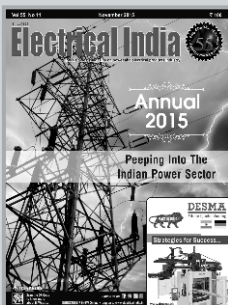
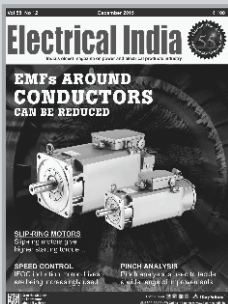
For the engineering of the PureSOx systems, Buss Shipping GmbH & Co. KG cooperated with SDC Ship Design & Consult GmbH. Detailed

engineering was handled by the shipyard German Dry Docks GmbH & Co. KG, which will install the systems following deliveries by Alfa Laval in January and February 2016. "The work between Buss Shipping, Alfa Laval, the shipyard and the

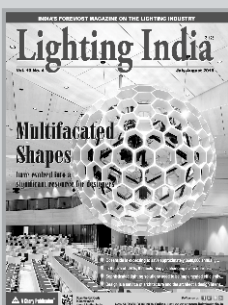
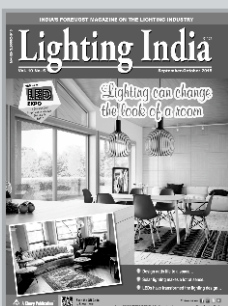
engineering consultant has been smooth and productive. Alfa Laval's scrubber design and project management experience, together with the strong cooperation from the rest of the team, will ensure a reliable outcome for Buss Shipping," says Mark Aarbodem, Project Manager at Alfa Laval.

"All parties have worked together to arrive at a compliant solution that will benefit our charter operations. Rather than paying for expensive fuel, our container vessels will be able to serve charter customers at a competitive price – while still retaining our margins," says Kölln. ■

***Buss Shipping will soon install Alfa Laval PureSOx exhaust gas cleaning systems on two of its container vessels...***



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- Universities, Technical & Research Institutions

Several Others...

# Airedale To Officially Reopen Rawdon Facility In May

**L**eeds manufacturer, Airedale International, will be fully operational from its redeveloped Rawdon facility in January 2016. However, an official opening of the new site will be held in May 2016. The business, which designs and manufactures high technology cooling systems for data centres, healthcare, industrial and commercial environments worldwide, suffered a fire in September 2013 – but quickly recovered by relocating to temporary facilities near Leeds city centre – while the old building was demolished and redeveloped.

Over the course of the last few months production has been moved back to the facility on a phased basis, ahead of the official handover from the contractor, BAM Construct UK, on 18<sup>th</sup> December 2015. The 100-strong administrative team remains at the firm's interim home but has planned to start the New Year from the new facility, completing the relocation.

Originally a mill operated by L J Booth, Airedale acquired the site in 1979, gradually extending the layout including the addition of an extension that was opened by HRH the Duchess of Kent in 1984. With an approximate area of 22,000 square metres, the new facility occupies broadly the same footprint – but is designed around the needs of a 21<sup>st</sup> century manufacturing business.

Together with the significant investment in new capital equipment, Airedale will enjoy even greater efficiencies in operation. The facility also includes a state-of-the-art Research and Development (R&D) facility, which, with the capacity to test systems of up to 2 Megawatts, is believed to be one of the largest of its kind in northern Europe. A wide range of temperatures and voltages can be applied when testing systems, replicating divergent global conditions under which units are likely to operate when exported to their final destination.

Airedale's Managing director, Clive Parkman, said, "After a year where we celebrated further awards successes for innovation in both product development and service delivery, we fully expect 2016 to mark another landmark in Airedale's history. Our on-going R&D programme will see us continue to set the bar for the development of high efficiency, high performance systems and solutions and we're targeting new geographical and vertical markets to supplement our existing base."

"With more than 600 people employed by the group in the UK, South Africa and Dubai, jobs and livelihoods depended on our ability to overcome the significant challenges that faced us in September 2013. I would like to thank our workforce, customers and suppliers for their loyalty to the business, he added. ■

*Together with the significant investment in new capital equipment, Airedale will enjoy even greater efficiencies in operation...*



*A view of the rebuilt Rawdon facility...*

# Interview

***"The scale and quantum leap in growth is yet to be observed..."***



***FX Multitech Private Limited*** is an eminent firm engaged in distribution and export of high quality engineering products. In an e-interview with ***Electrical India***, ***Venkat Raja Rao***, Director, ***Rollfin Evaporators***, which is a division of Fx Multitech, is addressing some questions put by ***PK Chatterjee***. Excerpts...



## How is the Indian HVAC&R market evolving?

The evolution process in the HVAC&R industry has been slow and steady during the formative years due to taxation structure and an elitist tag attached to it.

However, the rationalisation of duty structure, increasing disposable incomes, focus on increasing efficiency & productivity et al have led to a quantum jump in air-conditioning needs & requirements from all conceivable segments.

Latest & innovative technologies are being introduced and available in the market for users to consider in their applications.

Similar domino effect is also seen in the refrigeration, albeit at a slower pace due to varied applications and target segments.

However, HVAC&R market is poised for further growth with the advent of new and innovative technologies, end user demands, challenges in refrigerant changeover, which no doubt will open up new avenues in our industry.

## What are the underlying forces that are accelerating the growth of this industry in India?

Similar to any other industry, HVAC&R industry is driven by technology, norms from regulatory agencies and demands from end user segment. Following are the major forces driving the changes viz:

- **Technology:** with the introduction of new technologies and push from manufacturers & consultants, few end users are keen to adopt innovative designs, which will ultimately benefit them in terms of performance & energy efficiency. Technologies like variable speed & DC compressors, oil free VFD driven compressors, EC motors, PLC based controls, BMS systems etc., have made deep inroads into day to day applications within the industry.
- **Energy efficiency:** With soaring energy prices, it is increasingly becoming critical to use energy efficient components and systems to reduce the overall operational costs.
- **Refrigerant phase-out:** India being a member and signatory of the Montreal and Kyoto protocols, has been adapting to change over to new and substitute refrigerants though at a slower pace, due to extended deadlines of the HFC refrigerants.
- **Star ratings:** Labelling of appliances especially for air-conditioners by BEE is a good initiative towards attaining energy efficiency norms. This should be gradually extended to refrigeration equipments to ensure overall parity in the industry.

## What are the very prominent challenges in this industry at present in India?

The challenges faced by our industry are manifold, However, below are some which are critical for the sustenance of growth in the coming years:

- **Lack of skilled manpower:** there is serious dearth of young engineers who want to pursue their careers in HVAC&R industry. Efforts should and are being made by corporates in association with academia to

bring awareness and potential about our industry.

- **Training:** there is a dire need to 'learn, unlearn & relearn' at all levels of skilled workforce on new technologies, systems & procedures, best practices etc., to ensure optimised systems and trouble free operation.
- **Standards:** For air-conditioning, there are well defined governing rules from ASHRAE, ISHRAE, IGBC etc which governs major project design and execution. Unfortunately, due to diverse applications within refrigeration segment, common standards & guidelines are missing.  
Efforts are being made by industry bodies to introduce guidelines & compliance thereof, which brings a sense of standardisation on project scope, design and implementation.

## How are these challenges being addressed internationally?

Industrialised and developed nations are ahead on the learning curve, and are the front runners in terms of developing and adapting to new technologies. The business modus operandi, scale and skill sets being different, Indian counterparts always have to take a leaf out of their experience and adapt that to local conditions, which hitherto is being effectively carried out by MNCs operating out of India.

## What is your opinion on the Paris agreement (COP 21)?

COP 21 is an ongoing international platform aiming to stabilise and reduce harmful effects of greenhouse gases on the environment. Climate change is a hot topic all across the globe with countries experiencing abnormal weather patterns during the past few years. India as a developing nation and a key emerging market, has been able to influence its position in the forum, and procure benefits & relaxations to the HVAC&R industry based on local needs & challenges in adopting and switch over to new technologies. We can still continue to expect time lag in adoption of new refrigerants considering shift to new technologies by industry users at large.

## What steps should be taken by the Indian HVAC&R industry to lower power consumption?

As elaborated earlier, new innovations & technologies are available in the product portfolio of various organisations, which result in overall improvement in reducing energy bills to the end user. I assume it's the continuous joint effort from producers & consultants in educating & specifying to clients on their projects, which will garner required attention toward energy efficiency.

Secondly, in the refrigeration side of our industry, basic system norms & guidelines are critical to ensure efficiency & efficacy of the systems proposed. Steps & initiatives are already taken up by ASHRAE, ISHRAE, AAR etc to bring adherence to norms. However, adherence to norms & strict compliance to the expected is the key to success.

### What kinds of products are you providing, especially supporting the 'Make in India' movement?

Well, FX group has always been into import and distribution of diverse AC&R equipments, mainly from reputed European principles. The 'Make in India' programme initiated by the Modi government, entails start of green field projects for manufacturing or assembling considering India as a hub and potential to export to neighboring SAARC & ASEAN countries. We have informed our principals, who don't have presence in Asia, about this golden opportunity, considering the immense potential the local market has in terms of refrigeration needs.

Considering capex investment with facility outside their home country, calls for due diligence and SWOT analysis – before they consider India as a favourable destination for local manufacturing as well as an export hub. We will have to adopt a wait & watch attitude before favourable investment comes to India.

### What kind of support is necessary from the government to boost the growth of the Indian HVAC&R industry?

The HVAC&R industry in India has grown by leaps and bounds in the past couple of decades. Air-conditioning today is no longer a luxury, but has become an absolute essential for cleaner environs and boosting productivity.

However, on the refrigeration side, and especially Cold Chain from farm to fork level, there is immense scope considering wastage of products both at production & distribution level. While immense strides have been taken in this direction both by the government and industry bodies, the scale and quantum leap in growth is yet to be observed. There is still lot of unorganised activities and standalone units, which is not still providing the necessary impetus to the segment.

Govt does provide support in terms of subsidies etc, however it has a trickle-down effect in the segment. Either there are project delays, loan

approvals not forthcoming or business scale not favourable etc., which is an impediment in the growth process.

The regulatory agencies should ensure speedy process for timely project take-off, thereby ensuring overall improvement in food quality and reduction in energy consumption.

### How are you supporting phasing out of HFCs through your company's products?

HFCs even though don't pose any danger to the depletion of ozone layer, they are potent greenhouse gases, which affect climate change. Europe and other industrialised nation are the frontrunners in this endeavour, and already have products in their baskets suitable for natural refrigerants. Finally, availability of refrigerant both for manufacturing and service, shift from current to alternate refrigerants, the cost associated toward this transition, which technology is best suited for our localised conditions etc., are some of the contentious questions being posed by the industry. Users will drive the way industry would move forward to a cleaner and greener environment for future generations.

### What is your message to your existing and potential buyers?

I strongly believe and advocate on the following two pronged strategy:

- Long term view: many projects in cold chain are being looked at short term view, which dilutes the whole essence of the end application. This myopic approach leads to lot of heart burns when either the produce is not of the expected quality or projected returns are abysmally low.
- Total cost of ownership: today unfortunately most of the projects are executed based on capex cost. Opex cost is given a blind eye. As the idiom goes 'penny wise, pound foolish' approach leads to drain in resources to all stakeholders in the value chain. ■

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The background of the advertisement is a large industrial facility, likely a refinery or chemical plant, featuring complex piping, structural steel, and a tall distillation column. In the foreground, there are several large blue industrial units, which are Aggreko chillers, with yellow safety railings. The Aggreko logo is positioned in the top left corner. Two glowing orange lines, resembling energy or data paths, curve across the upper portion of the image, starting from the left and ending near the top right.

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# SAVING OVER

## £1000 A Week In Energy Costs

*Cool-Therm carried out a turn-key project for the client involving the safe removal of the existing chillers, replacing them with new Turbomiser machines. The changeover was successfully completed while maintaining continuity of cooling to the building, so that it could continue to function as normal...*





## Before...

**H**igh efficiency Turbomiser chillers installed at North Somerset Council's headquarters in Clevedon are saving the organisation more than £1000.00 a week in energy costs.

Cool-Therm installed two Turbomiser TMA 400kW chillers at the council's building at Castlewood earlier last year (2016), working closely with the council's M&E and energy management department.

The high efficiency, oil-less chillers, which run on virtually frictionless magnetic levitation bearings, replaced three aging Hitachi machines which were approaching the end of their operational life.

The existing chillers, rated at 569kW each, were considered to be oversized for the application following major changes to the building's occupancy and usage, resulting in high maintenance costs, poor control and reliability.

Cool-Therm carried out a turn-key project for the client involving the safe removal of the existing chillers, replacing them with new Turbomiser



## After...

machines. The changeover was successfully completed while maintaining continuity of cooling to the building, so that it could continue to function as normal.

The project took two months to complete, and involved the staged removal of existing units and installation of new chillers with major work completed out of office hours to minimise disruption on site.

Crane lifts posed a particular challenge due to the location of the building near the sea front, with high winds and unpredictable conditions affecting roof-top working.

The Cool-Therm team worked closely with Steve Hodges, Principal Mechanical, Electrical and Energy Engineer, North Somerset Council, to ensure the existing chillers were removed safely and the new Turbomiser craned accurately into position.

Accurate placement was important as the new Turbomiser chillers were manufactured with connection positions designed for hook-up to the existing fixed on-site services.

Due to the proximity of the site to the sea, and the risk of metal corrosion from onshore wind and salt-laden air, the heat exchange coils on the chillers were treated with a heavy duty Heresite protective coating designed for use in harsh environments.

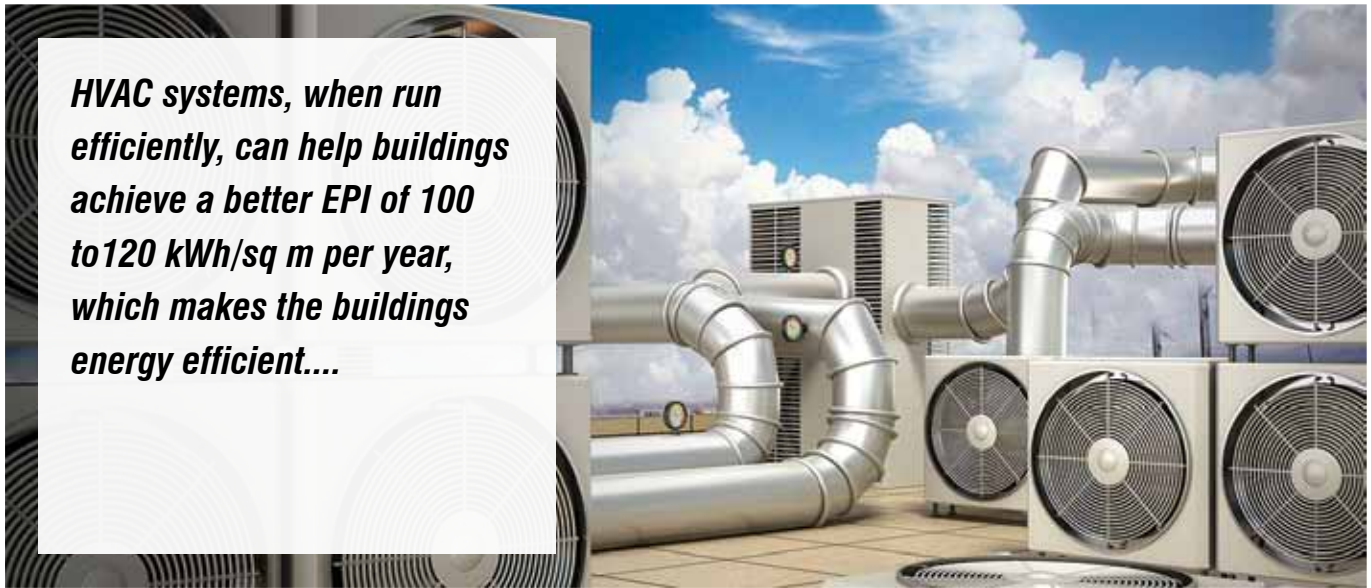
The chillers, which have an ESEER rating of more than 4.9:1, are equipped with a MODBUS gateway, enabling their performance to be monitored via the internet and any alarms to be interrogated and diagnosed remotely. Following the installation, the council reports that the chillers are saving in excess of £1000.00 in energy running costs a week.

Steve Hodges said, "The Turbomisers offer a proven high efficiency solution, and the results to date confirm the anticipated savings. We are very pleased with the high quality approach and professionalism of Cool-Therm in delivering the turn-key package, and look forward to the savings that will continue to accrue over the life-time of the plant." ■



# Energy Saving In The HVAC Industry

***HVAC systems, when run efficiently, can help buildings achieve a better EPI of 100 to 120 kWh/sq m per year, which makes the buildings energy efficient....***



The Energy Statistics 2015, released by Ministry of Statistics and Programme Implementation, of Government of India, shows the estimated electricity consumption in India during 2013-14 was 882,595 GW. This has grown at the Compound Annual Growth Rate (CAGR) of 8.84 percent between 2005 and 2006 and 2013 and 2014. Out of the total consumption of electricity in 2013-14, domestic households accounted for the 22.5 percent and the commercial sector accounted for 8.72 percent. Electricity consumption in the commercial sector has increased at a much faster pace compared to other sectors during 2005-06 to 2013-14 at a CAGR of 8.82 percent. A large quantity of incremental electricity demand will come from the residential and the commercial sectors in India. Energy demands are expected to triple by 2025 and the need to implement energy efficient technology is on top of the agenda.

## Role of HVAC in Energy Efficiency

According to the Indian Society of Heating, Refrigeration and Air Conditioning Engineers (ISHRAE), most commercial buildings have an Energy Performance Index (EPI) of 200 to 400 kWh/sq. m per year. Heating, Ventilating, and Air Conditioning (HVAC) equipment take a major share of electricity bills for residential, commercial and industrial applications, leading to tremendous pressure on energy sources, and ultimately impact the climate. This can be eliminated by deploying energy-efficient measures that are energy saving as well as help in cost cutting. HVAC systems comprise 40 percent of the energy consumed by

buildings in India; hence, HVAC remains the primary focus area for energy savings through system upgrades and optimisation.

The International Energy Agency has indicated that energy efficiency is likely to supply more additional energy than oil through to 2030, supporting energy-efficient innovations. The HVAC industry is also eyeing a huge opportunity through energy efficiency for increased scale of business. HVAC systems, when run efficiently, can help buildings achieve a better EPI of 100 to 120 kWh/sq. m per year, which makes the buildings energy efficient. Such concepts have brought a paradigm shift in HVAC technologies and trends, where majority of the changes are aimed at energy efficiency and higher energy performance. HVAC systems are now designed not only to meet energy standards but also to meet codes like Energy Conservation Building Codes (ECBC), American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE) standards to achieve higher levels of Green building Leadership in Energy and Environmental Design (LEED) rating, etc.

The HVAC industry is also keen on improving its energy efficiency by continuous Research and Development (R&D) to develop products that not only use less energy but also are environment-friendly. The main offender for polluting the environment is the refrigerant used in HVAC systems. New age refrigerants like HFC-32 (R-32) enable products to be made compact, and helps curtail greenhouse gas emissions, thus guaranteeing better energy efficiency.

Redesign and right sizing of chilled water and condenser pumps, deploying high efficiency compressors, demand-based control are some



of the recent improvements in existing HVAC plants to increase energy efficiency and performance effectiveness of the plant. Such measures can reduce up to 35 to 50 percent of energy consumption of a commercial HVAC system.

High efficiency chillers, variable speed drives, variable air volume boxes, and dedicated individual control are some of the popular energy efficiency techniques adopted by HVAC industry to achieve higher efficiency. The concept of using Dedicated Outdoor Ventilation (DOAS) and Demand Control Ventilation (DCV) system are now widely used in developed markets to ensure adequate ventilation and to strike a balance between human comfort and energy efficiency. DCV using CO<sub>2</sub> Sensors, Dedicated Outdoor Air Systems (DOAS), chilled beams, night pre-cooling, thermal storage system for cooling, displacement ventilation, gas-fired chillers, and control cooling tower fans by sensing ambient wet bulb temperature are few of the important energy conservation measures on HVAC system.

Apart from installation of new energy-efficient solutions, the HVAC industry is also promoting various means and methods to effectively maintain existing systems to avoid degraded energy performance of the equipment. For example, water treatment program for tube cleaning in centrifugal chillers, to avoid formation of scale or iron deposits on the microbe site. Energy saving of 10-25 percent can be achieved if the tube cleanliness is maintained.

Other issues, with respect to centrifugal chillers, such as reduced condenser flow rate, sub-optimal refrigeration levels, oil contamination in refrigerant, leaks in the compressor, etc., when monitored and maintained effectively would result in approximately 3 to 20 percent energy savings.

On the other hand, rooftop units undergo circumstances that cause degraded energy performance, for instance, economizer failure, problems with the sensor, airflow and thermostat control, suboptimal refrigerant charge, etc., which can be checked and adjusted in order to achieve an estimated savings of 5 to 35 percent.

Additionally, it is important to note that whole building integration is one of the key factors influencing the HVAC energy efficiency. Integrated buildings pave way for higher energy efficiency.

Conscious planning and implementation of energy-efficient solutions by the HVAC industry can consistently save up to 40 percent of energy consumed in commercial, residential, and industrial buildings in India.

By 2025, total energy demanded by households and commercial buildings would account for almost 800,000 GW and with energy-efficient HVAC solutions and practices, demand can be downsized by 330,000 GW than business as usual.

This is estimated to save INR 900 billion (based on current cost of power generation), for the economy. Hence, HVAC systems play a very critical role in defining the future of energy efficiency – and are expected to bring a positive and sustainable change in the Indian buildings environment. ■

**Suganya Rajan**  
Industry Analyst  
Energy & Environment Practice  
Frost & Sullivan

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# Energy Savings Through Dedicated Outdoor Air Systems (DOAS)

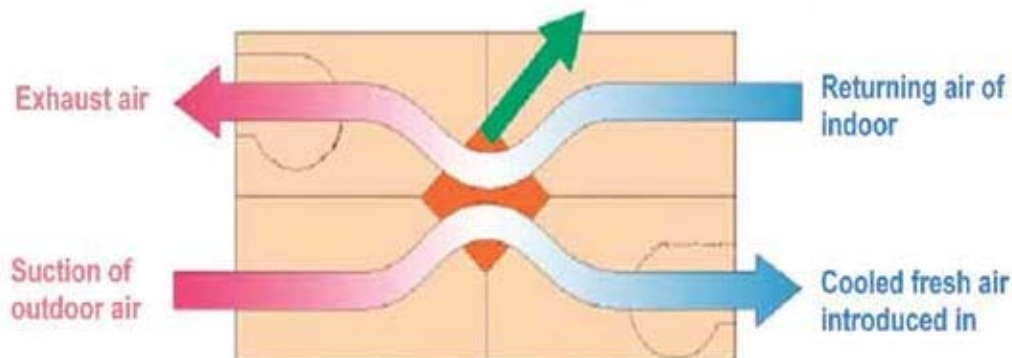
*When the DOAS removes enough extra moisture from the make-up air to handle the building interior load, energy savings can be obtained by running the separate, sensible cooling only, interior cooling system at higher evaporating temperature, improving the energy efficiency...*



## Structure of Heat Exchanger

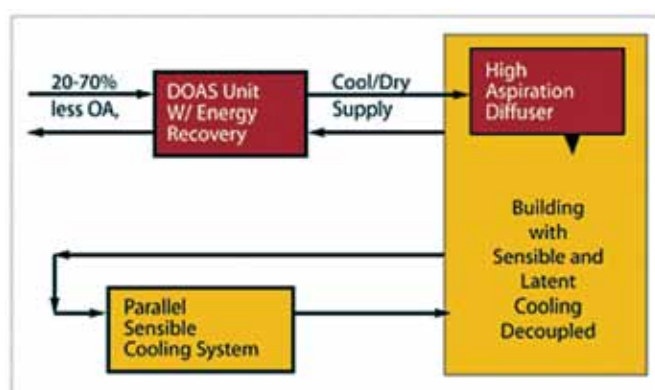


1. Excellent water absorbability exchanging efficiency reaches 75%;
2. Super fire-retardant  
Safe and reliable
3. Mildew-proof, clean & healthy.



**D**edicated Outdoor Air Systems (DOAS) condition the outdoor ventilation make-up air separately from the return air from the conditioned space. This approach to handling ventilation make-up air results in superior humidity control by dealing with the primary source of humidity in most buildings – ambient humidity carried in by the ventilation air – directly at its source. When the DOAS removes enough extra moisture from the make-up air to handle the building interior load, energy savings can be obtained by running the separate, sensible cooling only, interior cooling system at higher evaporating temperature, improving the energy efficiency. Further energy savings are realised by providing only the amount of ventilation air necessary and by using enthalpy recovery for the building exhaust air to pre-cool the make-up air.

## Background



It is common practice in commercial building air conditioning to combine ventilation make up air with return air from the building, condition (cool or heat) this air as needed, and distribute the conditioned air to the interior space, with or without zoned temperature control.

This approach to handling ventilation make-up air has received considerable attention in past several years. The impetus for this attention has been the growing realisation of the penalties and difficulties involved in meeting ASHRAE Standard 62 (Ventilation for Acceptable Indoor Air Quality) requirements throughout the conditioned space of a commercial building, with effective humidity control, particularly in the context of energy efficient approaches such as variable air volume.

In practice, vapour compression cycle air conditioning systems are often unable to maintain comfortable humidity levels in the conditioned space, when humid ventilation make-up air is mixed with building return air prior to the cooling coil.

Handling the treatment and distribution of ventilation make-up air and of return air from the occupied space with separate, parallel systems offers a number of potential advantages over conventional VAV systems that help overcome the problems discussed above. Many of these advantages directly result in significant energy savings.

The ventilation make-up air system can be sized and operated to provide the ventilation air flow rate required by code (e.g., ASHRAE -STD 62) to provide acceptable indoor air quality and provide this flow rate regardless of the interior temperature, without any need to oversize the

ventilation rate. The ventilation rate can be constant, or it can be varied based on the building operating/occupancy schedule or in response to the actual occupancy (on a real time basis). Moreover, a DOAS allows easy verification that the system supplied the minimum OA quantities to different portions of a building. Energy recovery heat exchange between the make-up air and exhaust is readily implemented in this configuration, reducing peak cooling and heating loads to condition make-up air.

The predominant humidity load in most commercial building in most climate areas is the humidity brought in with the ventilation make-up air (in hot weather). Consequently, the entire humidity load for the building can be handled efficiently by separately conditioning the make-up air so that excess ambient humidity is removed (along with additional capacity to cover internal moisture sources).

With the ventilation make-up air separately conditioned, with the entire building humidity load handled in the process, the recirculated indoor air conditioning system can be operated to maintain temperature control. Because this is intended for sensible cooling only, the cooling can be operated at a higher than normal temperature (approximately 55°F evaporating temperature vs. 40°F to 45°F, typically) preventing moisture condensation and increasing the COP of the compressor. In addition to providing independent temperature and humidity control, this is an ideal situation for VAV. The conditioned air flow rate is varied in proportion to the net cooling or heating load, saving significant amounts of blower power during the large proportion of the year when full heating or cooling capacity is not required. Meanwhile, the parallel ventilation make-up air system continues to deliver the appropriate amount of air for IAQ purposes. Note that this applies to both chilled water based systems and to DX systems.

## Performance

DOAS achieves energy savings via three primary factors –

- Optimal use of the ventilation air provided (allowing compliance with ASHRAE 62 with the minimum quantity of outdoor air),
- Ready use of enthalpy recovery to precool the outdoor air, and
- Allowing the interior load to be handled at higher refrigerant temperature and COP.

Category	Percent Energy Saved	Comments
Space Heating	8-12%	OA ~50% of heating load 20% reduction in OA
Space Cooling	15% - 20%	OA ~ 25% of cooling load 20% reduction in OA For internal loads, ~20% COP increase (11oF evaporator temperature rise)
Ventilation (air moving) power	0%	Reduction of over-ventilation offset by ~CAV function of OA unit

*Energy Savings of DOAS versus Conventional VAV.*



Characteristic	Result	Comments
Technical Maturity	Current	
Systems Impacted by Technology	All HVAC	
Equipment	Heating, cooling, and ventilation systems	
Readily Retrofit into Existing Equipment/Buildings?	Depends	A DOAS needs many more duct connections
Relevant Primary Energy Consumption (quads)	4.0 quads	All non-individual cooling and ventilation systems; OA heating energy
Technical Energy Savings Potential (quads)	0.4 to 0.5 quads	10% reduction in heating 17% reduction in cooling Approximately no net impact on ventilation energy
Approximate Simple Payback Period	Potentially immediate	Potentially lower first cost (in new construction and major renovation); includes benefit of additional rentable space
Non-Energy Benefits	Improved humidity control and occupant comfort	By delivering more appropriate space conditioning to different zones, zonal control decreases temperature swings, improving occupant comfort and possibly increasing productivity. In applications with small indoor humidity loads and low infiltration, a DOAS allows de-coupling of the latent and sensible load management by managing the OA (primary) humidity source separately.
Peak Demand Reduction	Yes	Yes, by ensuring only that occupied areas receive space conditioning during peak demand periods; a DOAS further reduces peak demand by decreasing OA cooling loads, which approach maximum values during peak demand periods.
Most promising Applications	Buildings with large amounts of variably occupied space, such as office buildings, hospitals or schools. DOAS systems provide larger benefits in regions where the OA conditioning burden is larger.	
Technology "Next Steps"	Demonstration of energy saving and superior humidity control, design software.	

#### *Summary of Dedicated Outdoor Air Systems Characteristics.*

The combination of a DOAS with a sensible cooling only VAV system saves energy by reducing total ventilation air flow and by handling sensible cooling loads more efficiently. In a DOAS, ASHRAE 62 ventilation requirements can be met with less ventilation air flow due to the inherent precision of the DOAS in delivering required ventilation flows in the aggregate and in the individual zones in the building. In space cooling mode, energy saving include the benefit of higher chilled water temperature for the sensible portion of the load.

In addition to energy savings, DOAS systems provide superior indoor humidity control over a wide range of outdoor temperature and humidity levels. This can prevent mold growth and promote healthier indoor conditions. On the other hand, in contrast to a conventional VAV system, DOAS generally precludes economizer operation at levels above and beyond those needed to satisfy OA requirements, as the DOAS would most likely not include additional ventilation capacity.

#### **Cost**

A general perception exists that replacing one single purpose system with two parallel systems – the DOAS and the interior thermal load systems will result in increased installed equipment costs due to installation of additional (more) equipment. In new construction or major renovations this is not necessarily accurate.

#### **Perceived barriers to market adoption of technology**

To the extent that use of DOAS is viewed as a means to enhancing the performance of zoned, VAV, and/or DCV system designs, first cost is also an issue, as well as the contractor's willingness to sell and estimate costs for zoning jobs. However, energy savings will certainly complement the payback period of the capital cost. ■

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# PUT THIS ENERGY

## Hog On A Lean Diet

A composite image showing a globe of the Earth, centered on the Atlantic Ocean and showing parts of North America, South America, and Europe. The globe is being held by several hands of different skin tones (white, light brown, dark brown) reaching up from the bottom and sides. The background is a soft, out-of-focus blue and green. A semi-transparent white banner is overlaid across the middle of the image, containing the text "Save Money & The Planet".

**Save Money & The Planet**



***If the commitment made by India at Paris is to be honoured, then there is an urgent need to reduce the energy consumption by air conditioners since they have the lion's share of the energy budget of every building...***

**A**ir conditioning consumes most energy in a household. The chart (Yearly Energy Bill of a typical flat at Mumbai... ) gives an idea of how the energy bills increase because of using Air Conditioning machines at home. Thus, in today's situation, we need to be more careful while using ACs at home or elsewhere...

### Menu for A Lean Diet for the Energy Hog

- A. Reduce load
- B. Use star rated equipment
- C. Use low energy appliances
- D. Maintain well.

We shall consider load reduction methods only as under:

#### A. Solar Load

- Structure cooling
- Radiant barriers
- Low transmittance glazing
- Thermal barrier/reflective paint for walls and roof
- Night sky cooling.

#### B. Fresh Air Load

- Wind towers
- Indirect evaporative coolers
- Exhaust air recuperators

#### C. Internal Loads

- Use low energy lighting and machines
- Isolate hot spots and vent them directly
- Wear light clothing.

this article will discuss structure cooling and fresh air load reduction only.

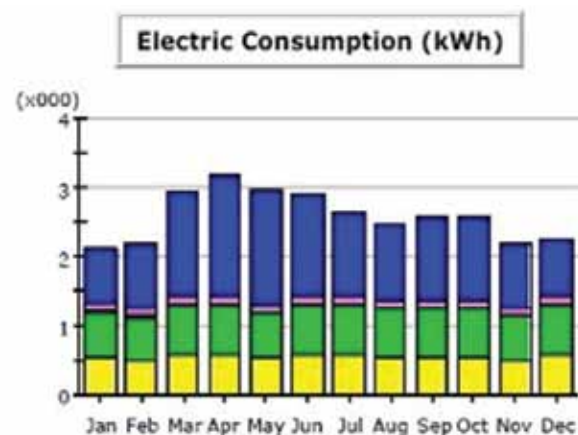
### Solar Load Reduction Methods

#### Structure Cooling

There are many ways to do that, but the best way is to keep the structure cool by using the techniques used by our ancestors. Our heritage buildings remain naturally cool even today without using any energy. While they used massive construction as thermal storage to absorb and water bodies to drain out the solar heat, we can't use that technology any more in modern times, due to space and cost constraints. This article will examine in detail the various modern methods based on our Heritage techniques to achieve the same result.

##### 1. A Simple Method suggested by CBRI Roorkee.

Prof. S. P. Jain devised a method where a layer of gunny bags was laid on



**Yearly Energy Bill of a typical flat at Mumbai...**

**Blue Bars are for Air Conditioning...**

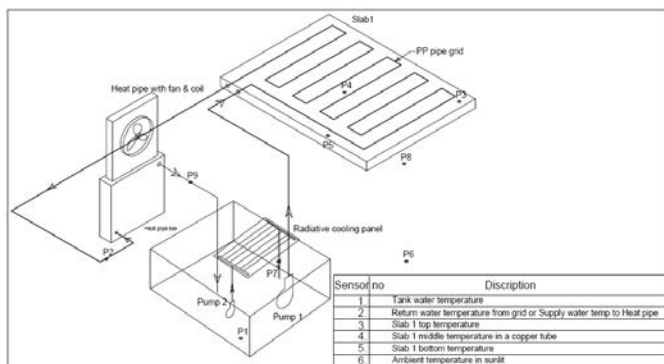
a roof and wetted frequently. The water absorbed the heat from the roof while evaporating. He claimed that about five litres of water could produce one ton of cooling. He called it Roof Surface Evaporation Technique. A hand pump replaced the lost water.

2. An improved version had a coir mat, an electric pump with timer, and garden sprinklers. In both the versions, the terrace was not usable and there were waterproofing issues.

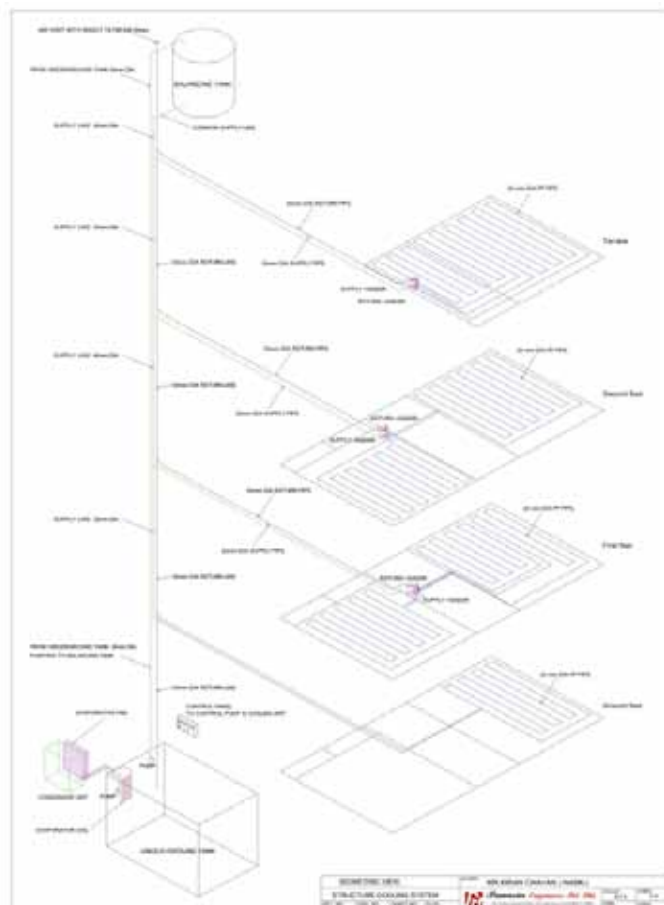
3. The author devised a system of welded iron pipe grids filled with water and connected to a unit that was an evaporative cooled heat exchanger.

The entire system was under vacuum, so the water boiled at 24 Deg.C. and absorbed the solar heat from the slab. The vapour travelled to the heat exchanger and the condensed water returned to the grid by gravity. The pipes were laid on a cured concrete surface and covered by screed. The system kept the roof bottom below 30 Deg.C in Jaipur in mid-summer. Here the issue was the need for highly skilled welders in the field. Also, it would be impossible to repair a leak if it developed after the screed was applied. However, the Jaipur system is still working after almost twenty years.

4. The current versions use corrugated polypropylene tubes in one or more serpentine loops, each a 100 meters long, connected to supply and return manifolds. They are laid on the surface of a new or renovated concrete roof, tested for leaks and then covered with screed. A special fitting allows repairing of leaks.



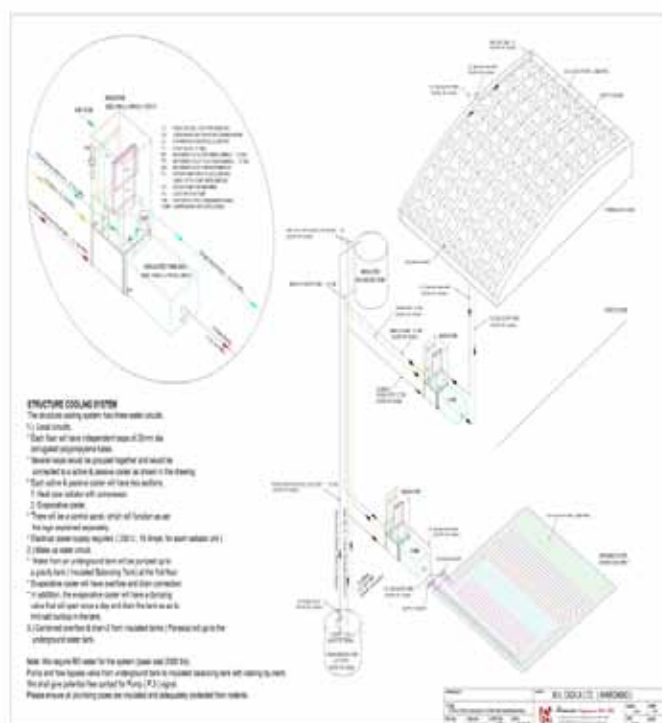
Dia 1. Experimental setup at Mumbai...



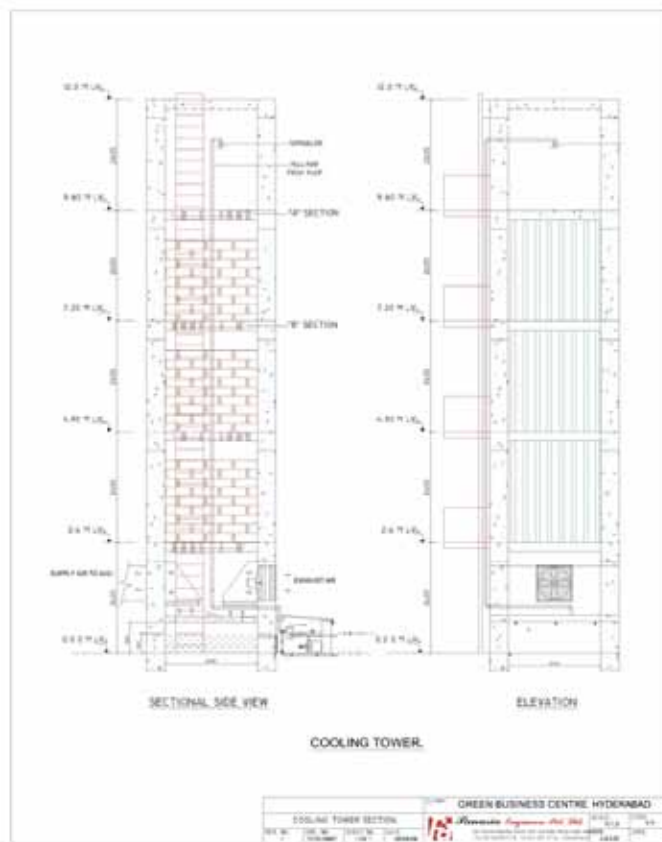
Dia 2. Multi storey system at an office at Nashik



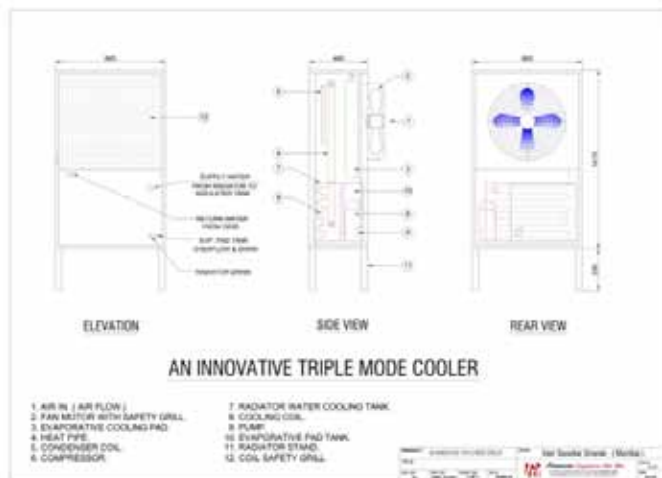
Dia 4. Piping layout for Veer Savarkar Smarak at Mumbai...



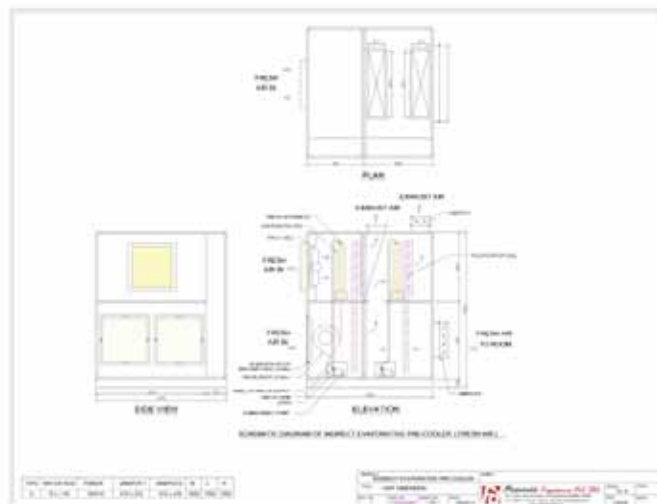
Dia 3. Floor and roof cooling system for a museum at Dholka, Gujarat...



Dia 5. Wind tower at G. B. C. at Hyderabad...



**Dia 7. Triple mode cooler with radiator, cooling pad and chiller...**



**Dia 8. Indirect evaporative fresh air cooler...**

A low pressure pump draws water from a tank and circulates it, via the manifolds, slowly through the loops, so that it returns very hot. The way in which the return water is treated before it returns to the tank gives rise to several variations.

**a. Variant 1.** In this simplest system, the hot water is dumped directly into an underground tank that acts as thermal storage for the day's collection of heat from the roof. It mimics the massive heritage walls. Water can hold twice as much heat by volume as masonry can for the same temperature rise. This heat is dissipated into the ground by conduction.

This system is viable for very small structures; otherwise the tank becomes too large.

**b. Variant 2.** In order to reduce the underground tank size, the hot return water passes through a fan cooled radiator. Thus, most of the heat is dumped into the air and only tepid water enters the tank. Even this heat is removed by again circulating the water through the radiator at night. (Dia. 1)

**c. Variant 3.** When space constraint or rocky ground prevent an underground tank, then a small tank is placed below a larger radiator. This works well in mild climates like Mumbai.

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**d. Variant 4.** In hot zones, an evaporative cooling pad, with its own tank and pump, is added before the air enters the radiator. A thermostat activates this only if the ambient temperature rises above say 30 Deg. C. It shuts off below the set point, thus saving water. (Dia.7 )

**e. Variant 5.** Multi story application. Here, an insulated overhead tank supplies cooling water to each floor via a downpipe feeder, controlled through an inlet valve. However, in order to prevent the build up of high pressure in the plastic pipe, the discharge end has no valve. It is connected to a vertical return pipe through a vacuum free connection. The vertical pipe connects to an underground tank. The radiator unit is placed outside at ground level. The cooled water is supplied to the overhead tank, when required, by a pump. (Dia. 2 & 3)

**f. Variant 7.** If a more precise control is desired, a small chilling unit can be added to any of the variants. (Dia 2 & 7). A little goes a long way here, A one TR unit maintains the bottom of a 3000 sq. ft. at 30 Deg. C. at one installation at Mumbai. (Dia. 4) The danger is that if the structure is cooled below the ambient dew point, then there will be condensation on it.

This system is neither a jugad nor a cheap copy of imported systems. It has been developed in over twenty years of research as to how our own Heritage buildings remain cool without any equipment. Several undergraduate and two Master's level research has been done in our own pilot unit. The zero energy concept of thermal storage and drain is not found in any of the imported systems. By adding a small P.V. system, our system becomes a zero impact one.

All materials are made in India. The system is simple and affordable enough to be replicated by anyone with basic technical skills. There are no patents or copyrights.

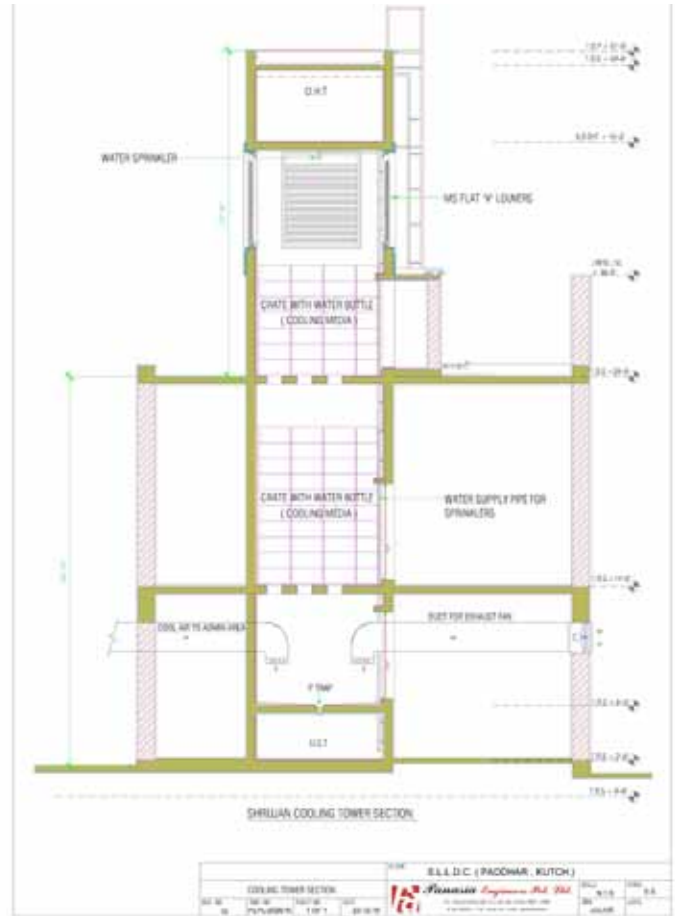
## Fresh Air Load Reducing Methods

**1. Wind Towers with thermal storage:**– Fresh air load can be greatly reduced in hot dry climates by an innovative use of Wind Towers. There are two variant designs. Both are based on the wind towers used in some Middle Eastern and European countries, but they are stuffed with impervious thermal mass that is evaporatively cooled at night. During use, the thermal mass absorbs the heat from the incoming fresh air and greatly reduces its load. The two towers are:

- **The wind tower at GBC, Hyderabad:** There are two 15 metre tall towers, stuffed with concrete hollow blocks. Their holes are aligned so that air and water can flow downwards through them. Water is sprayed only at night. During the day the dry blocks perform sensible cooling before feeding to the AHU. The total load reduction was 80 TR. for the two towers. (Dia 5)
- **An improved design at Shrujan Centre in Kutch:** Here, the concrete blocks were replaced by water filled plastic bottles. They were placed in crates and were simply stacked. Water and air entered the top. humid air went outside at night. Dry cool air was fed into the ducts during the day. There is no air conditioning. Water bottles are much cheaper and lighter than blocks. Also, water can hold twice as much heat per degree than masonry for the same volume and weighs less. (Dia.6)

### 2. Exhaust Air Recuprators

These devices are heat exchangers that pre-cool the incoming hot outside air by cold air being exhausted out. They are quite useful for applications that require large percentage of fresh air, such as auditoriums and operation theatres. There are two types.



*Dia 6. Wind tower with plastic water bottles at The Shrujan Centre Kutch...*

- Rotary wheel type has media that absorb sensible and latent heat from incoming air in one section and give it up to the exhaust air in the other section.
- Heat pipe type uses evaporative pads and heat pipes to do the same. However the two air streams are totally isolated.

### 3. Indirect Evaporative Pre-Coolers

Both use heat pipes and evaporative pads. The two stage design cools more, but uses more primary air and water, (Dia. 8)

## Conclusion

If the commitment made by India at Paris is to be honoured, then there is an urgent need to reduce the energy consumption by air conditioners since they have the lion's share of the energy budget of every building. The simple, effective and affordable solutions described in this article use the time tested techniques of our ancestors and modern technology developed and validated in India that uses only materials made in India, can go a long way towards achieving our goal if implemented on a mass scale. ■

**Surendra Himatlal Shah**  
BE Mechanical Engg, Clemson University, USA  
Founder & Owner of Panasia Engineers Pvt Ltd



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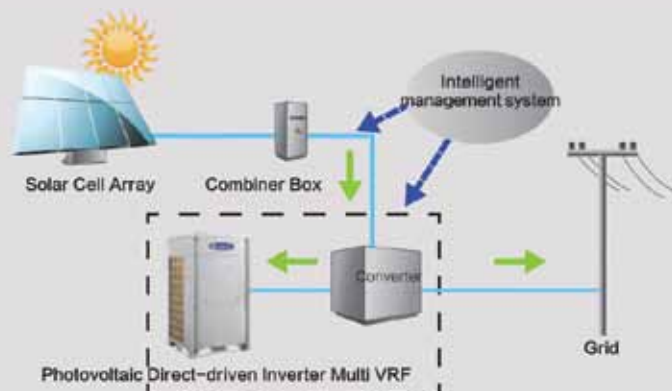
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# Klima-Therm To Distribute Gree's Pioneering Product

*Klima-Therm, the expanding chiller and air conditioning specialist, has been appointed a distributor for Chinese manufacturer Gree's pioneering photovoltaic-powered VRF air conditioning and split systems...*







### Photovoltaic Air Conditioning and Power Generation Mode

The photovoltaic power will give priority to the air conditioner. When photovoltaic power generated is more than the air conditioner's consumption demand, then the residual power will be sent to the grid...

Klima-Therm have been providing a portfolio of air conditioning, heating and air movement products, along with technical back-up service and maintenance, to the Building Services Industry for over twenty-five years. The company has recently signed a distribution agreement with Gree for centrifugal chillers. Thus, Klima-Therm is the only UK supplier of the manufacturer's full air conditioning range.

As part of its commitment to establish the brand in the UK, Klima-Therm will stock all popular models of Gree VRF and split air conditioning, plus spares. It is expanding its air conditioning team and recruiting new staff to support the roll-out.

Gree's pioneering direct-drive photovoltaic-powered VRF system is the first commercially available system of its kind in the world. The hybrid solar-electric technology can save end users up to 30 per cent of their cooling energy costs.

The units can be used in heat-pump mode to produce heating or hot water - a typical application being to fill a residential storage tank with hot water during the day ready for consumption in the evening.

Conventional PV-powered VRF systems collect solar energy and produce electrical power, feeding it to a DC-AC converter for use by the VRF. Gree's system uses an advanced

power management system to overcome the need for a DC-AC converter, feeding electricity from the PV array directly to the air conditioning system.

This removes the efficiency losses associated with power conversion, boosting the system's efficiency and cost-effectiveness. When conditions allow, surplus electricity not required for air conditioning can be fed back into the grid, giving end users an income from feed-in tariff, further tilting the economics in favour of PV-powered air conditioning.

Roberto Mallozzi, Managing Director of Klima-Therm, said, "This latest agreement with Gree means that Klima-Therm is now the only supplier in the UK offering the manufacturer's full range of industry-leading products."

"The Gree name may not yet be very well known in the UK. However, the company combines impressive scale as a manufacturer - now producing one in three of all air conditioning units sold in the world - with outstanding technical skills and innovation. Many of the leading air conditioning brands trust Gree to manufacture their branded products for them. It demonstrates that the company's capabilities and quality are beyond reproach," he added.

Gree operates nine manufacturing plants, seven in China plus facilities in Brazil and Asia. It has capacity to produce some 60m

residential air conditioners and 5.5m commercial systems a year.

A core Gree philosophy is to move from "Made in China" to "Created in China." In pursuit of this, the company manufactures all key components such as compressors and motors.

It has 52 research centres and 570 laboratories, employs 8,000 engineers, and holds more than 14,000 technology patents.

Gree spent over £410million on research and development in 2013 alone, and holds CE, UL and TUV certification.

Tim Mitchell, Sales Director, Klima-Therm, said, "The market for air conditioning in the UK is changing. We believe that demand for sustainable solutions, that harness renewable energy such as solar power and other sources, is set to increase significantly - not least because of the mandatory requirement to include renewable energy in planning proposals.

"Gree's PV-powered VRF and centrifugal chillers offer a very attractive approach, on both economic and environmental grounds. And because of Gree's clever technology, PV-powered systems can operate in UK conditions. We believe these technologies are set to become mainstream options in the very near future - indeed we already have active enquiries."

# R2 SYSTEM

## A Boon For HVAC Industry

***Most leading brands in air conditioners like Mitsubishi Electric have introduced two-pipe or three-pipe VRF systems that provide simultaneous heating and cooling...***

**E**nergy Efficiency is a very important factor these days, which drives our aim to become a Global, Leading Green Company.

The Mitsubishi Electric Group established Environmental Vision 2021 to contribute to the development of a sustainable society, and is advancing initiatives to achieve a low-carbon, recycling-based society. While this vision represents the company, we aim to become by the 100<sup>th</sup> anniversary of our founding in 2021, our ultimate goal is to make lasting social contributions as a leading green company.

To this end, we are working to strengthen our corporate constitution and to contribute to society. Strengthening our corporate constitution refers to disciplining ourselves to use less energy and fewer resources in our manufacturing, and increasing production efficiency to the highest level possible. Specifically, this means reducing waste generated during production and thoroughly implementing the "3Rs" of resources: reduce, reuse and recycle.

Mitsubishi Electric products are made with a vision of "Eco Changes for a greener tomorrow," which is our commitment to the society to develop energy efficient products.

### A winning combination for HVAC

With the advance of technology, Variable Refrigerant Flow (VRF) type air conditioners are now capable of transferring the heat energy from inside the room to hot water. VRF is an air-condition system configuration where there is one outdoor condensing unit and multiple indoor units. The arrangement provides an individualised comfort control, and simultaneous heating and cooling in different zones.

Most leading brands in air conditioners like Mitsubishi Electric have introduced two-pipe or three-pipe VRF systems that provide simultaneous heating and cooling.

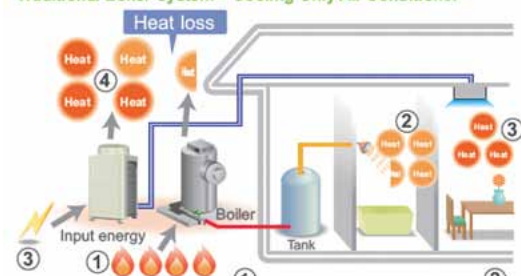
### Two-pipe system with simultaneous heating and cooling operations

Heat recovery type VRF systems are normally available in water cooled and air cooled systems. In water cooled type systems, a double heat recovery is possible. The refrigerant from the condenser and indoor units (which are a mix of vapour and liquid) is passed through a set of valves, which separates the gas and liquid and diverts the flow of

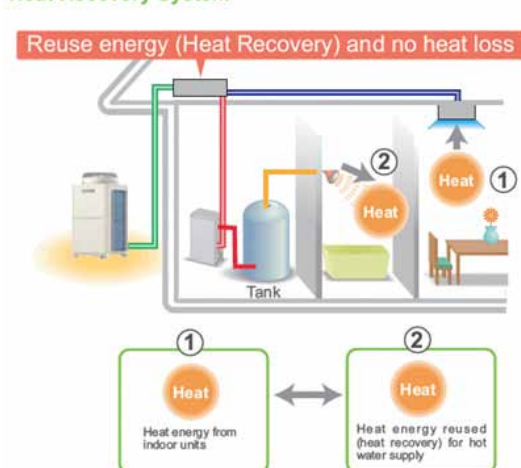
refrigerant to required indoor units, depending upon the heating or cooling requirement. These types of VRF units can have special type of indoor units known as air to water type. They have refrigerant and water passing through a plate type heat exchanger and depending upon the temperature settings on the water side part of indoor, the valve assembly diverts the refrigerant for heating or cooling of water.

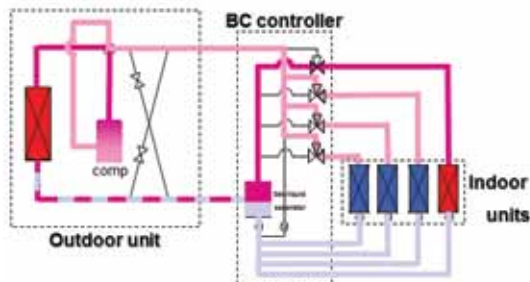
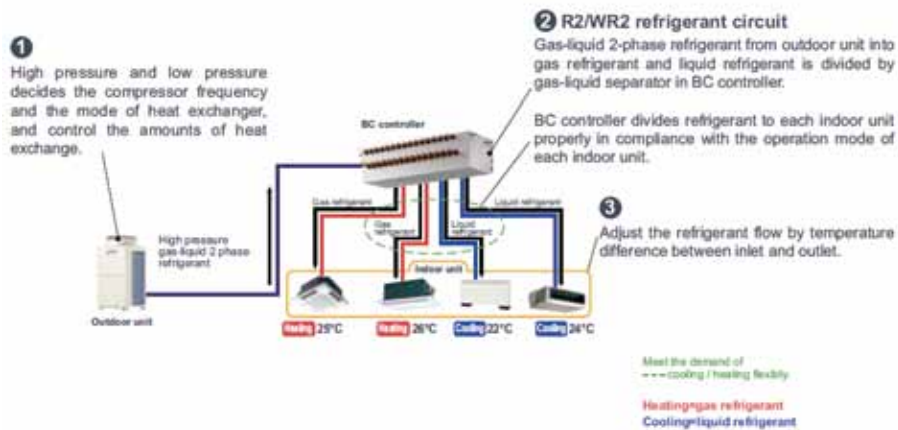
What helps is that a maximum amount of energy efficiency is obtained after water is heated when the other indoor units are in cooling operation. It also means that a simultaneous generation of hot water and heating by indoor units is possible during the operation. While air

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**0% Cooling with 0% hot water Generation.**  
(Most energy efficient operation)...

cooled outdoor units will expel unutilised energy into the atmosphere, water cooled units can be used for double heat recovery – expelling the energy to water which can then be used for pre-heating the water for other applications.

A schematic diagram of typical heat recovery system with hot water generation has been mentioned above.

## Features of the system

The system provides two types of air to water indoor units. The first one is the Auxiliary unit which recovers available heat from air conditioning operation with a maximum water temperature up to 40°Celsius. The second one which is the Booster unit contains an additional inverter driven compressor which can generate water up to 70°Celsius.

The number of air to water indoor units have to be selected depending upon the hot water requirement. The capacity of the auxiliary unit is available with 12kW and 25 kW heating capacity with a maximum temperature output up to 40°Celsius. The capacity of Booster unit is 12 kW with a maximum outlet temperature up to 70°Celsius. The maximum connectivity of air to water type indoor units are 50 to 150 per cent when

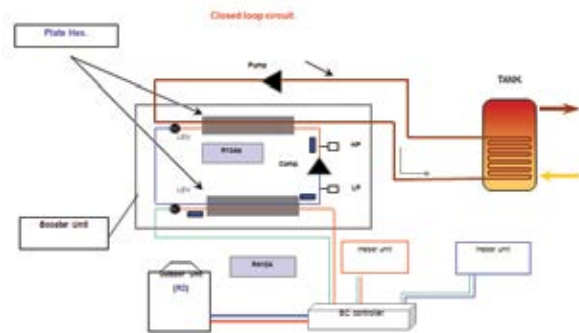
connected with standard indoor units. Outdoor capacity is available from 08 HP to 36 HP capacity in air cooled type.

The selection of the capacity of air to water indoor units is calculated on the basis of a formula like this:

Capacity of Air to water indoor (in kW) =  $\{(T_2 - T_1) \times 1 \text{ Kcal/Deg hour} \times \text{Water qty in Liters}\} / 860$ .

(Adding a safety factory of 15 per cent to the derived kW from above calculation is important) T<sub>2</sub> – water outlet temp, T<sub>1</sub>- water inlet temperature.

The maximum water flow rate for the Air to Water series is 0.6 m<sup>3</sup> / hr to 2.15 m<sup>3</sup> / hr, the operating pressure is 1 Mpa and the output temperature for water is 10° to 40°Celsius (70°Celsius for Booster type units).



Schematic diagram of Booster unit...

## A technological marvel

While understanding the features is easier, some questions still remain unanswered. An often-asked question is: can we get hot water even if the air conditioner is not operating? The answer to this is an emphatic yes! Hot water is generated irrespective of the operation of the other indoor units. However, the best efficiency is when other indoor units with a capacity equal to the air to water type indoor units are operating in cooling mode. (50% cooling, 50% for heating water).

Since the air to water type indoor units are multi-pass storage type, increase in temperature at a single pass is generally less than 5°Celsius. A storage tank with a closed loop system and multiple passage of water to increase the temperature is needed.

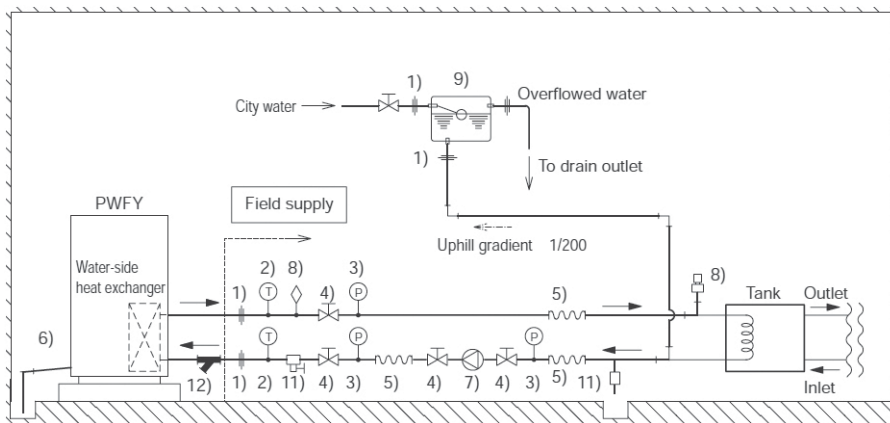
Many people wonder whether such a system can be used along with a solar type-water heater. Air to water type indoor units can be used to increase the feed water temperature to solar water heaters and can also be used to maintain the temperature of the water at a desired level during the night or in low sunlight periods. This applies mainly to the hotel industry where the requirement of hot water is high during early morning hours.

## System for India?

One may also wonder if this type of system is suitable for the water quality that is available in India. While using the system in India, it is mandatory to use a closed loop system with the storage tank and air to



Items		Lower mid-range temperature water system Water Temp. $\leq 60^{\circ}\text{C}$		Higher mid-range temperature water system Water Temp. $> 60^{\circ}\text{C}$		Tendency	
		Recirculating water	Make-up water	Recirculating water	Make-up water	Corrosive	Scale-forming
Standard items	pH (25 $^{\circ}\text{C}$ )	7.0 ~ 8.0	7.0 ~ 8.0	7.0 ~ 8.0	7.0 ~ 8.0	○	○
	Electric conductivity(mS/m) (25 $^{\circ}\text{C}$ ) ( $\mu\text{S/cm}$ ) (25 $^{\circ}\text{C}$ )	30 or less [300 or less]	30 or less [300 or less]	30 or less [300 or less]	30 or less [300 or less]	○	○
	Chloride ion (mg Cl/liter)	50 or less	50 or less	30 or less	30 or less	○	
	Sulfate ion (mg $\text{SO}_4^{2-}$ /liter)	50 or less	50 or less	30 or less	30 or less	○	
	Acid consumption (pH4.8) (mg $\text{CaCO}_3$ /liter)	50 or less	50 or less	50 or less	50 or less		○
	Total hardness (mg $\text{CaCO}_3$ /liter)	70 or less	70 or less	70 or less	70 or less		○
	Calcium hardness (mg $\text{CaCO}_3$ /liter)	50 or less	50 or less	50 or less	50 or less		○
Reference items	Ionic silica (mg $\text{SiO}_2$ /liter)	30 or less	30 or less	30 or less	30 or less		○
	Iron (mg Fe/liter)	1.0 or less	0.3 or less	1.0 or less	0.3 or less	○	○
	Copper (mg Cu/liter)	1.0 or less	1.0 or less	1.0 or less	1.0 or less	○	
	Sulfide ion (mg $\text{S}^{2-}$ /liter)	not to be detected	not to be detected	not to be detected	not to be detected	○	
	Ammonium ion (mg $\text{NH}_4^+$ /liter)	0.3 or less	0.1 or less	0.1 or less	0.1 or less	○	
	Residual chlorine (mg Cl/liter)	0.25 or less	0.3 or less	0.1 or less	0.3 or less	○	
	Free carbon dioxide (mg $\text{CO}_2$ /liter)	0.4 or less	4.0 or less	0.4 or less	4.0 or less	○	
Ryzner stability index		—	—	—	—	○	○



The recommended water quality standard is JRA-GL02E or equivalent...

water type indoor units. This helps in maintaining the efficiency of the system, and also prevents scaling inside the air to water type indoor units. Periodically PHE (Plate Type Heat Exchanger) inside the storage tank can be replaced. It is advisable to use de-mineralised water between the PHEs. ■

**Dipu Manuel**  
Product Manager, VRF Systems  
Living Environment Division  
Mitsubishi Electric India

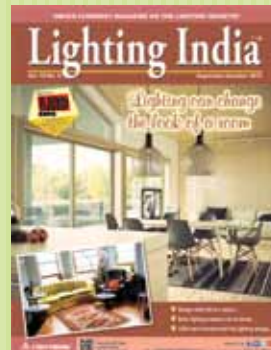


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## 4 Significant Proposals To Mitigate Climate Change

As per Lima-Paris Action Agenda (LPAA), a profound renewable dynamics is spreading to all countries in the world, with regions working to leapfrog to clean energy. The business case for renewable energy has never been stronger. Renewables are now the most cost-competitive sources of power in many parts of the world and renewable power accounted for more than half of all capacity additions in the global power sector since 2011. Actions on these fronts are well underway... Several initiatives have been launched at the COP and LPAA Energy day at the Paris Climate Summit, to accelerate this dynamics.

Four significant proposals are:

1. The Global Geothermal Alliance (GGA), is set to achieve a 500% increase in global installed capacity for geothermal power generation and a 200% increase for geothermal heating by 2030. The world contains vast geothermal energy potential,

proven across nearly 90 countries. But almost 90% of this remains untapped with roughly 12 GW installed so far.

2. India elaborated on its recently launched International Solar Alliance (ISA), which aims to align countries with the abundant solar potential to push the development of solar energy technologies. With the focus on accelerating the deployment of solar energy in developing countries, the alliance will work to meet the multiple objectives of access, economic prosperity and sustainable growth. The transformation potential of the Alliance lies in its prospective membership of over 120 countries of Tropic of Cancer and Tropic of Capricorn.

3. The Africa Renewable Energy Initiative (AREI) has announced its ambitious plans for deployment of renewable energy in Africa: build at least 10 GW of new and additional renewable energy generation capacity by 2020 and 300 GW by 2030.

Considering that current total electricity generation in Africa is roughly 150GW this is a massive contribution to the climate change effort by the region.

4. The Africa Clean Energy Corridor has demonstrated progress and announced the beginning of similar work in the West Africa power pool. Clean Energy Corridors are regional platforms to accelerate deployment of renewable energy in larger region – thanks to economy of scale and optimisation of resources.

Regional planning, capacity building, regulation convergence and tapping and connecting the best potentials are at the programme of these partnerships. Combined electricity demand in the Eastern Africa and Southern African power pools could exceed 1000 terawatt-hours by 2030 – more than double their 2010 power consumption. Renewable energy can help meet this rising demand. ■

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# Clean Room Devices & Technologies



*The healthcare industry is a major user of cleanrooms, as micro-organisms or dirt must not be injected or infused into patients through their products...*



A room in which the concentration of airborne particles is controlled, and which is constructed and used in a manner to minimise the introduction, generation, and retention of particles inside the room and in which, other relevant parameters, e.g., temperature, humidity, and pressure, are controlled as necessary, is called a Clean Room. This is a precise description of Clean Room.

### Clean room for industrial segment

The cleanroom is a modern phenomenon. Although the roots of cleanroom design and management go back for more than 100 years. Need for a clean environment for industrial manufacturing is a requirement of modern society. Clean rooms are needed because people, production machinery and the building structure generate contamination. As will be discussed later, people and machinery produce millions of particles, and conventional building materials can easily break up. A cleanroom controls this dispersion and allows manufacturing to be carried out in a clean environment.

A major user of clean rooms is the semiconductor fabrication industry, where processors are produced for use in computers, cars and other machines. Micro particles can cause an electrical short circuit and ruin the semiconductor. To minimise contamination problems, semiconductors are manufactured in clean rooms with very high standards of cleanliness.

Industry	Product
Electronics	Computers, TV-tubes, flat screens
Semiconductor	Production of integrated circuits used in Computer memory and control
Micromechanics	Gyroscopes, miniature bearings, compact-disc Players
Optics	Lenses, photographic film, laser equipment

*Some clean room applications.*

### Clean room for hospitals

The table shows manufacturers who require the absence of micro-organisms, as their growth in a product (or in a hospital patient) could lead to human infection. The healthcare industry is a major user of cleanrooms, as micro-organisms or dirt must not be injected or infused into patients through their products. Hospital operating rooms also use cleanroom technology to minimise wound infection.

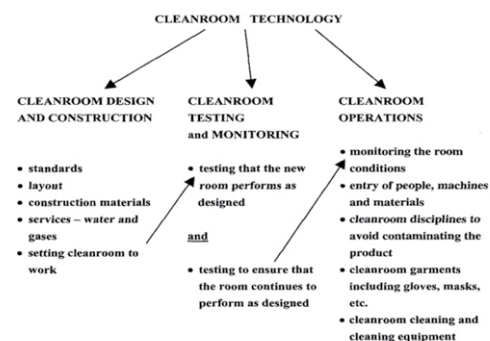
Industry	Product
Biotechnology	Antibiotic production, genetic engineering
Pharmacy	Sterile pharmaceuticals, sterile disposables
Medical Devices	Heart valves, cardiac by-pass systems
Food and Drink	Brewery production, unsterilized food and drink

*Some clean room applications.*



### What is cleanroom technology?

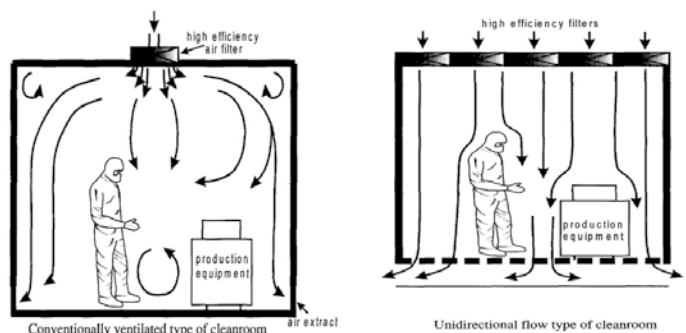
As can be seen now, cleanroom technology can be divided into three broad areas. These areas can also be seen to parallel the use of the technology as the cleanroom user moves from firstly deciding to purchase a room to finally operating it.



Various parts of cleanroom technology and their interconnections

### Two types of clean rooms are popular

- 1) Conventionally Ventilated
- 2) Unidirectional Flow Type



**S. D. Bandal**  
E&T/C Graduate Engineer  
from COEP, Pune



# Interview

**"By 2018 we are targeting 50% revenue from export..."**

**Gandhi Automations Pvt Ltd** specialises in designing, manufacturing and installing customised products conforming to the highest safety standards complemented with reliability and energy efficiency. All their products are designed and manufactured with European collaboration – using innovative and creative engineering technology. In an exclusive interview with **Cooling India**, **Samir Gandhi**, **Director**, of the company is revealing some facts related to their business to **PK Chatterjee**. Excerpts...



### **How is the entrance automation products' market evolving in India as well as abroad?**

Entrance Automation is a very big market in European and other developed countries. India is a developing country, and with economic revival and infrastructure growth – we see tremendous potential in entrance automation products in the next 10 years.

When we started business in 1996, this industry was in nascent stage, awareness about the product was very less. With multinational companies setting up their businesses and warehouses in India, our business picked up in terms of volume.

Today, domestic Indian companies also understand the importance of entrance automation products, and prefer installation of the same in their projects.

### **Are you sourcing all automation components (drives, actuators etc.) from abroad?**

We have tie up with many European companies for drives and actuators. But these components are manufactured as per our instructions. We get them designed as per our requirements.

### **What is your forte that led Gandhi Automation to capture more than 70% market share in India?**

Major reasons that made us fit to capture 70% of market share in India are: firstly we are manufacturers. Quality, Safety, Innovation and Customer Service are the four parameters on which we work at Gandhi Automations.

We are manufacturers of High Speed Doors, Dock Levelers, Dock Shelters, Motorised Rolling Shutters, Motorised Gates, Boom Barriers, etc. Since we manufacture our delivery time is less, our after sales service is best in the industry. Our response time to customer is less than 24 hours.

### **How do you ensure high quality of your products?**

We have state-of-the-art manufacturing and warehousing facility where we have a team of skilled and experienced engineers, every product is test and retested by our engineers before it is dispatched to customers site.

### **What is the significance of high-speed doors application (say) component or cost wise?**

High Speed Doors are most useful where there is frequent movement of goods or people – and at the same time you want to avoid dust, outside

temperature, humidity etc. from entering inside the facility. Opening and closing of door has to be quick enough to isolate the outside environment and internal facility.

The cost of same depends on various factors – such as size of the door, number of applications to be installed etc.

### **What kind of new technologies and/or innovative designs are you putting in your loading bay equipment?**

Innovation & improvement is a never ending process at Gandhi Automations, we firmly believe in the same. Our research & development is working on few innovations in loading bay equipment products.

We will soon launch a new product exclusively for warehouses, which we feel will be very useful for warehouses, details of the same I will tell you only after launch.

### **With our respected prime minister's call for 'Make in India,' how will the Indian entrance automation industry reshape itself?**

As I told you earlier, next decade will be a boom for infrastructure industry (warehouses, manufacturing plants etc.), thus we see a lot of potential in entrance automation products.

Multinational companies are coming to India and setting up plants here. They will definitely need entrance automation products. We see 20% year on year growth in this segment.

### **What are GAPL's plans on the anvil?**

"We are number 1 in the domestic market. There's huge untapped international market for our products. Our products meet international safety standards – and with right kind of product portfolio, we are ready to export to this huge international market."

With increased globalisation and countries opening up for business, we see a great opportunity in neighbouring countries also. For instance in Myanmar, in last few years, foreign investments have increased from few million to several billions of dollars (300 million in 2009 to 5 billion dollar in 2014). The government has relaxed import restrictions and abolished export taxes. Such policies boost our confidence, and we will venture in such countries. "Our current target for export is Gulf Countries and European Countries. In coming years we will be targeting neighbouring countries like Bangladesh, Indonesia, Bhutan, Sri Lanka and few African countries. I have visited few of these countries, and we have better products to offer them, than the ones they are currently using. By 2018, we are targeting 50% revenue from export." ■



# Living With Humidifiers And Dehumidifiers



*For most people, a relative humidity level between 40–50% in the summer and 30–50% in the winter is ideal. If the humidity drops below that level, the dry air can irritate our nose and throat, and dry out our skin, eyes and lips. Dry air may also shrink wood, damaging furniture, floors and walls....*

Human always desire a comfortable climatic conditions for his living and when natural climatic conditions with time and region are not in human control, he has always strived hard to achieve it with the help of technology. Humidity conditions (low or high) are also uncomfortable climatic conditions to human, and he looks for means to either increase or decrease humidity in his surroundings. Hot and cold, dry and humidity conditions make the surrounding unbearable to the inhabitants and make them dull and unpleasant. These conditions become more severe when the place has no facility for the environment air to handle at all, no ventilation, no air conditioning; just stay there naturally and exasperatedly.

The air in our home should range from 30 to 55 percent humidity. If the humidity is too high, mold and dust mites may thrive. Both are common causes of allergies. Mold also causes an unpleasant smell and can discolour surfaces. If the humidity falls too low, on the other hand, the people in home may suffer dry eyes and may develop throat and sinus irritations. Humidity levels determine whether we need a humidifier or a dehumidifier. We might need both machines at different times of the year.

In this direction, humidifiers and de-humidifiers play a significant role in making the surrounding environmental conditions more comfortable. Thus, humidifiers and dehumidifiers are useful appliances that help maintain optimal humidity in home.

### Humidification

For most people, a relative humidity level between 40–50% in the summer and 30–50% in the winter is ideal. If the humidity drops below that level, the dry air can irritate our nose and throat, and dry out our skin, eyes and lips. Dry air may also shrink wood, damaging furniture, floors, and walls. Additionally, low humidity can make our home feel colder, especially in the winter. A humidifier counter acts these effects, adding moisture to the air to boost the humidity back to comfortable levels. A humidifier is a device that increases humidity (moisture) in a single room or an entire building. In the home, point-of-use humidifiers

are commonly used to humidify a single room, while whole-house or furnace humidifiers, which connect to a home's HVAC system, provide humidity to the entire house. Medical ventilators often include humidifiers for increased patient comfort. Large humidifiers are used in commercial, institutional, or industrial contexts, often as part of a larger HVAC system.

### Types of humidifiers

Today, there are countless models of humidifiers to choose from. Humidifiers are mainly classified into two types – warm mist and cool mist. In homes with children, it is better to avoid warm mist humidifiers since a child may get burnt from the hot steam emitted. Also, warm mist humidifiers consume more electricity as they have to heat the water to produce steam. Cool mist humidifiers are considerably safer, but require more maintenance. These units require cleaning with soap and water every day and changing the filter annually. After deciding to purchase either of these, the next thing to consider is whether the humidifier should be ultrasonic, evaporative or steam-based. Here are the differences, benefits and disadvantages of each:–

- **Ultrasonic humidifiers:** These are among the cheapest yet most energy-efficient of all humidifiers. These units feature storage for water and oscillating plates. The vibrations of these plates transform water into a fine mist that is then blown out with a fan. The major problem of an ultrasonic humidifier is that it produces white dust as a by-product, which can pose a serious threat for people with breathing problems. However, the newer and costlier versions of ultrasonic humidifiers feature advanced technology that eliminates the problem of white dust.
- **Evaporative humidifiers:** These units work by releasing moisture into the air by blowing water with a fan. This is quite a hygienic choice since it does not pose the problem of dust being released into the room. In addition to being very energy-efficient, this system is noiseless, so it can be comfortably used in bedrooms.
- There are two kinds of evaporative

humidifiers – one with porous filters and the other with rotating discs. When it comes to maintenance, the system with porous filter is less preferable, since it can quickly get polluted with hair, skin, dust and other matter in the air and incur regular replacements. On the other hand, the rotating discs of the second group of humidifiers are made from hardened plastic, making them easy to clean and care for.

- **Steam-based humidifiers:** The moisture released by steam humidifiers can easily be regulated according to the extent of dryness in a room. The humidity control provided by these units is exceptionally hygienic since steam kills off germs and releases sterile moisture. That makes a steam humidifier an excellent choice for controlling humidity in nurseries or for people with respiratory illness.

Maintaining a steam humidifier involves regular removal of lime scale that may build up within the system. Compared to other humidifiers, steam ones are considerably economical. However, steam humidifiers consume more power than other versions of humidifiers.

## Benefits of using a humidifier

**Reduce risk of infections:** Viruses and bacteria can't travel as well in moist air. A humidifier could mean the difference between getting the flu this winter and remaining healthy.

**Softer, more vibrant skin:** Cold, dry air saps moisture from skin, which causes all kinds of problems, including dryness, dullness, flaking, and accelerated aging. A humidifier can help prevent all these damaging effects, and help maintain that glowing, vibrant look.

**Comfortable sinuses:** We always feel dry and tight feeling in our nose in the winter. Winter air can dry out our sinuses, lowering our resistance to bacteria and viruses. A humidifier will help overcome sinuses.

**Faster healing times:** (Say) you do end up with a cold, a sinus infection, or the flu. A humidifier will shorten your suffering. Keeping your nasal

*Humidifiers are not easy to use. All units, portable as well as those installed in central heating systems, must be cleaned rigorously. Otherwise, they tend to become contaminated with mold and bacterial growth.*

passages and your throat moist will help you heal faster, and will reduce symptoms like coughing and sneezing.

**Healthier houseplants:** Plants help pull toxins out of the air. But they can suffer in dry, winter air. Have you noticed that the soil is dryer than usual? Are the leaves looking droopy and sick? A humidifier can help keep your house plants healthy – which helps keep you healthy, too!

**Protected wood furnishings:** Dry air can damage wood furniture, as well as moldings and doors, causing them to split and crack. A humidifier can help preserve the integrity of the wood, maintaining your pieces for years to come.

**No growling morning voice:** Do you often sound like a bear in the mornings? That's dry

air getting to your vocal cords. Sound more like your normal self when you sleep overnight with a humidifier in your bedroom!

**Reduced heating bill:** Did you know that moist air feels warmer than dry air? It's true. If you add some moisture to the air, it will feel warmer, which can help you save on your heating bills this winter.

**Fewer electric shocks:** No one likes a static electricity shock – especially not the cat! But you may have noticed that in the winter, it's harder to avoid it. That's the dry air again. Use a humidifier and leave the lightning outside.

**Improved sleep:** If you or a partner snores, a humidifier may help. We tend to snore more if our sinuses and throats are dry. A moist environment also tends to feel warmer and more comfortable, which can encourage a good night's sleep.

## Precautions with humidifiers

Humidifiers are not easy to use. All units, portable as well as those installed in central heating systems, must be cleaned rigorously. Otherwise, they tend to become contaminated with mold and bacterial growth that may be blown through the house. Stop the humidifier and call the mechanic if there is development of any respiratory symptoms that may be related to the use of a humidifier.

- **Use distilled or demineralized water:** Regular tap water has minerals that create buildup in machine and promote bacterial growth. Distilled and dematerialised water contain fewer minerals and will save from having to clean as often.

- **Clean once a week:** This will help to do the next cleaning quickly and will keep home healthy.
- **Change filters regularly:** Follow the manufacturer's directions for changing the filter.

## Dehumidification

On the other hand, high humidity may spur mold and mildew growth, which can exacerbate allergies and rot our walls. Harmful dust mites, those microscopic organisms that particularly aggravate allergy and asthma sufferers, thrive in high humidity. They live in our





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- Pathologists
- Radiologists
- Physiotherapists

Several Others...

bedclothes, drapes, rugs, and the air in home. Removing excessive moisture from indoor air helps control these pests. Dehumidifiers also can help limit mold and bacterial growth. High humidity can also make the air feel much warmer, especially during the summer. Substantial condensation inside our windows is a good indication that humidity levels in our house are too high. Dehumidifiers remove moisture from the air. A dehumidifier is a device that extracts undesired level of moisture from the air to reduce the humidity level in the house. This curbs the growth of mold and dust mites. They are particularly useful in parts of the house where humidity collects, such as damp basements. Dehumidifiers are critical for households in humid climates with very old people or very young children, or for families with a history of allergies or asthma. Dehumidifiers draw air over cold coils, condensing out its moisture, before passing the air over warm coils and back into the room. Air conditioners also take a certain amount of moisture out of the air, but dehumidifiers do this much more efficiently. The condensed water drips into a container in the unit that has to be emptied. The water can be routed directly to a drain by means of a hose. Home dehumidifiers remove between 10 and 50 pints of water from the air each day, depending on the relative humidity. The capacity of a unit is measured by the number of pints it can remove in a 24-hour period at 60 percent relative humidity and at 80 degrees.

## Dehumidifier basics

Most dehumidifiers can be broken down into five component parts:

- Fan Compressor – This compresses and expands a refrigerant gas like freon to cool the dehumidifier's coils.
- Reheater – This captures and collects heat that the cooling process generates.
- Compressor cooling coils
- Reservoir

**A dehumidifier works on the following lines:**

- A fan collects air from the surrounding area and pulls it into the dehumidifier.
- As the air passes through, it comes into contact with the dehumidifier's cooled coils. These coils use condensation to pull moisture from the air. The collected moisture remains on the coils and drips into the dehumidifier's reservoir.

- The dehumidifier reheats the air and exhausts it back into the room.

A dehumidifier usually has a removable plastic bucket for a reservoir; most buckets also have a place where we can hook up a hose so the collected water can drain straight into a floor drain or pump. Many dehumidifiers also have a humidistat, which allows to set desired level of relative humidity. A humidistat has two parts: a sensing element and a relay amplifier. The sensing element includes two alternate metal conductors, and changes in relative humidity will cause electrical resistance between those conductors. The relay amplifier measures this resistance and sends a signal to turn the dehumidifier on or off. These basic components add up to a device that may make home feel a whole lot better.

## Types of dehumidifiers

The basic functional principle of a condense drying dehumidifier is really quite simple. A fan draws in humid air and carries it through a refrigerated evaporator. The air is cooled well below its dew point. The water condenses on the cold surface of the evaporator and drips into a water container or is led directly to a drain. Then the cold dry air continues through a hot condenser which heats it up and returns it to the room to pick up new humidity. This procedure is continued until the desired condition is achieved. To remove all of the water even with relatively dry air conditions, it is important that not all the air is cooled down by the evaporator as there is a risk that the dew point cannot be fully achieved. Instead only part of the air is led through the evaporator to ensure maximum condensation while the rest is by-passed as shown above. This results in a mixed 18°C and 85% RH air flow between the evaporator and the condenser. When passing the hot condenser the mixed air flow will ensure that the condenser is sufficiently cooled. The final result is an outlet air temperature from the dehumidifier of 33°C and 35% RH. The temperature is increased because energy is added by the compressor and by the latent heat from the condensation process. Dehumidifiers come in three main types: heat pump, chemical absorbent and dehumidifying ventilators. They all remove moisture from the air, but each has a slightly different method. The heat pump method draws in air with a fan and runs it across a cold coil to condense the moisture. Air is warmed

by a heat pump and returned to the room. Chemical absorbent dehumidifiers send damp air outside after a chemical drying agent absorbs moisture from room air. Dehumidifying ventilators use a sensor and exhaust fan to determine when humidity levels are high.

While refrigerative dehumidifiers may be the most well-known, desiccant dehumidifiers also do a great job of keeping a space nice and dry. True to their name, these dehumidifiers pull in air and pass it over a desiccant material such as silica gel. Desiccants naturally absorb moisture – that's why you'll find little packets of silica gel in new shoes or electronic goods. Because desiccant dehumidifiers don't need to cool air before dehumidifying it, this technology is really ideal for sub-zero conditions. Since the technology behind them is so simple and effective, dehumidifiers mostly vary in size and strength. Portable dehumidifiers are the kind that you usually see in the home improvement aisle; they're often plastic, relatively cheap and very lightweight. They're designed to be most effective in smaller spaces like a bedroom or kitchen. Restoration humidifiers are heavy-duty machines that can withstand harsh conditions – they're usually used to repair heavy water damage caused by hurricanes or other natural disasters. The largest models on the market, whole-house dehumidifiers, usually augment a home's existing HVAC system. You'll have to hire a professional to install one of those. Some manufacturers have also created specially sized crawl space dehumidifiers to address the humidity in storage areas and powerful dehumidifiers that are targeted toward the high humidity created by some indoor pools and spas. Whichever kind of dehumidifier you choose, it may help make your home a little greener.

## Precautions with dehumidifiers

Mold can grow in the drainage areas of a dehumidifier, so regularly clean the water basin with bleach. Also, smaller units may not dry out the air satisfactorily all the time so choosing a larger capacity unit is better. ■

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# Cooling The Tube

***The New Tube for London will bring the first walk-through air-cooled trains on to the deep-level Tube network, which includes the Central line - with the first trains due to be introduced in the 2020s...***

**S**t. Paul's is a London's underground station located in the City of London financial district that takes its name from the nearby St Paul's Cathedral. The station is on the Central line, between Bank and Chancery Lane stations. During summer, commuters passing through this station need proper cooling. They were being kept cool in last summer (2015) by an innovative fan chiller system, which pumped cold air onto the eastbound Central line platform.

At the heart of the new system - a first for the Tube network and designed and built by LU's cooling team - is a ventilation fan that pulls fresh air in from the street. The air is then cooled by a water chiller system which circulates 16 litres of cold water every second around the pipes in the ventilation shaft, cooling the air by up to seven degrees before it is blown onto the platform. The huge fan is capable of moving the equivalent of 15 double-decker buses full of air every minute.

## New Tube for London

In the past it had been challenging to lower the temperature on the Central line as traditional cooling systems had proved prohibitively expensive and difficult to install within the 115 year old tunnels and stations.

The New Tube for London will bring the first walk-through air-cooled trains on to the deep-level Tube network, which includes the Central line - with the first trains due to be introduced in the 2020s.

Until then, LU continues to seek innovative solutions to reduce temperatures during the summer months on the deep-level lines. Other measures currently aimed at cooling the Tube include:

- New air conditioned trains on the Metropolitan, Circle and Hammersmith & City lines, with 40% of the network covered by 2016
- The capacity of the underground St. Paul's station ventilation fans network has

been doubled and eighty three fans have been restored

- Portable fans installed within ticket and concourse areas, to increase air circulation at a number of stations
- The creation of a Cooling Innovation Centre to explore new efficient and environmentally friendly methods to cool the Tube.

## Big Engineering Challenge

David Waboso, LU's Capital Programmes Director, said, "We know travelling around London during the summer months can be uncomfortable which is why we are always looking for innovative ways to tackle the temperature. Cooling the Tube is a big engineering challenge, but we're making significant steps forward and, by the end of 2016, 40% of the Underground network will be served by air conditioned trains. Projects like the installation of a fan chiller system at St Paul's Tube station demonstrate how LU has some of the most skilled, creative people in the business when it comes to developing entirely new ways to cool London's Tube."

In addition, a larger fan chiller system is being installed this summer (2016) at a mid-tunnel ventilation shaft on the Victoria line between Walthamstow Central and Blackhorse Road Tube stations.

## Major Improvement

The work is being done to coincide with the period of major improvement works on the Victoria line this month, which will enable the operation of 36 trains per hour next year (2016). The new fan chiller system will be ready for next summer and mean more comfortable temperatures for passengers at the northern end of the Victoria line. LU's cooling team is developing proposals to continue the expansion of this innovative technology in the coming years. ■



*St.P auls station eastbu nd ook west.*

Source: wikimedia.org.  
Photographer: Sunil Prasanna (User: Sunil060902)

# Storage of Perishable Commodities

## Importance Of Humidity



***The more quickly the product is cooled, the longer it will remain marketable. Storage is the art of keeping the quality of agricultural materials and preventing them from deterioration for specific period of time, beyond their normal shelf life...***



**R**efrigeration has been the principal known method of successful storage of fresh fruits and vegetables to retain their freshness and flavour. When fruits and vegetables are harvested, they are cutoff from their source of water and nutrition and soon start to deteriorate. They lose weight, texture, flavour, nutritive value and appeal. Both time and temperature are important factors in post-harvest product deterioration. Cooling the harvested product control the rate of quality loss by slowing the rate of respiration. The warmer the temperature, faster is the deterioration and the shorter is the storage life, conversely, the cooler the temperature, the slower the deterioration and the longer the storage life. The more quickly the product is cooled, the longer it will remain marketable. Storage is the art of keeping the quality of agricultural materials and preventing them from deterioration for specific period of time, beyond their normal shelf life. Cold storage Control ripening retards aging, softening, texture and colour change, retards moisture loss, wilting, microbial activity, spoilage, sprouting and undesirable growth.

However, when the temperature of air in the cold store drops below its dew point, the moisture of air condenses as water on to the cold surfaces, particularly the cooling coils in the refrigeration system. As this air circulates around the chill store it warms, reducing its relative humidity. The warmer air draws moisture from any surface it can, including the produce itself. This leads to product weight loss - as much as 20% - and cells become less turgid, affecting the appearance, quality and shelf-life of the produce, all of which reduce the value of the stock. The solution? Raise the relative humidity (RH) to a level that's in equilibrium with the produce. Optimal conditions vary according to the specific type of fruit, vegetables, flowers or other food product being stored but, typically, a humidity of around 95% RH at a temperature just above freezing is needed but, even produce stored in warmer conditions benefit from a humidity level around 75% RH. The required moisture is introduced directly into the air, evenly throughout the store.

Humidification is a process by which moisture is provided inside a given space, where this is scarce or insufficient, by means of a humidifier. For storage of fresh products, the important factors are temperature, humidity, ethylene and odour, which need to be managed. Until recently, most of the stakeholders' attention was focused only on temperature. Loss of water from produce is often associated with a loss of quality, as visual changes such as wilting or shriveling and textural changes can take place. Leafy crops tend to lose water the most quickly. If using mechanical refrigeration for cooling, the larger the area of the refrigerator coils, the higher the relative humidity in the cold room will remain. It pays however, to remember that water loss may not always be undesirable, for example if your produce is destined for dehydration or processing to puree or sauces. Water loss of 3 to 6% is generally enough to cause a noticeable loss of quality and value. Stone fruits (peaches, plums and apricots) look shriveled when they suffer water loss of 4 to 5%. Root crops (carrots, beets, turnips, radishes) will lose water much faster if their tops are left attached, since the leaves will continue to transpire, taking water from the roots. Reducing the rate of water loss slows the rate of shriveling and wilting, causes of serious post harvest losses. If you sell produce by weight, every bit of water lost is also lost profits. Produce handled and marketed at 27°C and 60% RH (very adverse conditions, but not uncommon in Punjab in April and May) can lose a lot of water in a short time. Accurate humidity control (Table 1.0) is the key to maintaining quality fresh produce in cold storage.

Refrigerated air tends to be lower in relative humidity than is beneficial for storage of most horticultural crops. The simplest method of increasing relative humidity of the storage air is to wet the floor of the room or mist the storage containers with cold water and allow the water to evaporate. The dry air increases transpiration and water loss from the stored product, resulting in lost weight and lost value. Potatoes stored without added humidity can lose 10-12% of their weight over six months. The humidity of the air in storage rooms directly affects the keeping quality of the products held in them. If it is too low, wilting or shriveling is likely to occur in most fruits, vegetables, cut flower and related products. Maintaining humidity high enough in commercial storage is usually a greater problem than the occurrence of too high humidity. High humidity is beneficial for wound healing and periderm formation during curing of certain crops.

### RH can be controlled by

- Adding moisture to air (water mist or spray)
- Regulating air movement and ventilation rates in relation to produce
- Maintaining refrigeration coils in a cold room within 1°C or 2°F of air temperature
- Providing moisture barriers (insulation, liners, plastic films)
- Wetting floors in storage rooms
- Adding crushed ice to packages and displays (for tolerant crops)
- Sprinkling produce during retail marketing (leafy vegetables, cool season root crops, immature fruit crops)

### Benefits of humidification

- Raising the relative humidity inhibits moisture loss.
- The right humidity level ensures that product quality is maintained.
- Fresh, just picked appearance increases value.
- Improved profitability through maintained product weight.
- Longer storage and greater shelf life reduce waste.
- Direct room humidification ensures the right humidity level evenly around the store, maintaining produce quality throughout.
- Close humidity control means the right humidity for the right produce.

### Relative humidity

Relative humidity is defined as the ratio of the water vapour pressure in the air to the saturation vapour pressure at the same temperature, and is normally expressed as a percent. The difference in vapour pressure can cause water vapour movement from or to objects in contact with the air. The water holding capacity of air increases as the temperature rises; hence, air at 90 percent relative humidity at 10°C contains more water by weight than air at 90 percent relative humidity at 0°C. Never-the-less, water would be lost from a product at about twice the rate in a room at 10°C than at 0°C if the relative humidity is 90 percent in both.

High relative humidities (85 to 100 percent) are recommended for most perishable horticultural products to retard softening and wilting from moisture loss. For most vegetables, the relative humidity should be about 90 to 100 percent. If it is necessary to increase the relative humidity in rooms used for common storage, or air-cooled (non-refrigerated) storage, water may be sprinkled on the floor occasionally or misters may be installed. The relative humidities recommended are those that will retard moisture loss and do not favour excessive growth of



micro-organisms. Of major importance in maintaining adequate relative humidity in the storage air is providing good insulation, avoiding air leaks, and providing sufficient cooling surface so that the spread between the temperature of the refrigerating surface and desired commodity temperature is as small as possible.

Therefore, accurate control of refrigerant temperature is essential for maintain high humidities in a mechanically refrigerated storage. As the difference between the temperature of the refrigerating surface and the temperature of the air in contact with the refrigerating surface increases, the humidity decreases.

Produce Item	Typical Daily Weight Loss	Daily Weight Loss with 90+ % RH	Reduction in Weight Loss	Change in Appearance
Artichokes	4.05%	0.58%	85.68%	Noticeable
Avocados	0.38%	0.08%	79.62%	Very Minor
Broccoli	7.55%	0.75%	90.07%	Substantial
Brussels Sprouts	3.47%	1.54%	55.62%	Noticeable
Cabbages	1.39%	0.28%	79.86%	Noticeable
Carrots	4.65%	1.61%	65.38%	Substantial
Cauliflowers	2.04%	0.41%	79.90%	Noticeable
Celery	3.08%	1.29%	58.12%	Substantial
Grapefruits	0.64%	0.21%	67.19%	Noticeable
Grapes	1.46%	0.73%	50.00%	Noticeable
Lemons	1.17%	0.36%	69.23%	Very Minor
Lettuce	7.05%	0.92%	86.95%	Dramatic
Mushrooms	12.06%	5.90%	51.04%	Dramatic
Big Mushrooms	12.09%	4.58%	62.10%	Dramatic
Oranges	0.45%	0.22%	51.11%	Very Minor
Peaches	3.38%	2.23%	34.09%	Noticeable
Plums	0.83%	0.41%	49.79%	Noticeable
Radishes	5.88%	2.94%	50.00%	Dramatic
Strawberries	2.43%	1.11%	54.23%	Substantial
Tomatoes	0.23%	0.07%	69.30%	Very Minor

For example, if the air moving over the refrigerating surface is cooled to  $-1.1^{\circ}\text{C}$  and the surface temperature is  $-3.9^{\circ}$ , the relative humidity of this air will be about 78 percent, because any water vapour in excess of the amount that can be held at this relative humidity will condense on the coil. However, if air at  $-1.1^{\circ}\text{C}$  moves over a refrigerating surface maintained at  $-2.8^{\circ}$ , the relative humidity will be 89 percent and if, instead, the air moves over a refrigerating surface at  $-1.7^{\circ}$  (a temperature difference of only  $0.6^{\circ}$ ), then a relative humidity of 94 percent could be expected. Actual humidities obtained under these conditions of refrigerating surface and air temperatures will usually be somewhat higher than indicated, because not all the air comes in contact with the refrigerating surface. Thus, air leaving the chamber will be a blend of that which has lost moisture and that which has retained its original moisture content.

As the difference between refrigerant temperature and air temperature becomes narrower, a greater refrigerating surface is necessary. If air is

cooled from  $0^{\circ}$  to  $-1.1^{\circ}\text{C}$  during passage through a dry-coil bunker, considerable more surfaces will be required to accomplish this temperature reduction. With an adequate refrigerating surface and with the temperature of the surface controlled by automatic devices, there should be no humidity problem. When the refrigerating surface is not adequate to maintain the desired atmosphere humidity, pressure atomized or heat-vaporized water can be added to the air.

A system capable of supplying 4L of water/hour/ton of refrigeration should be able to maintain 95 percent relative humidity under any reasonable conditions (figure 1.0). Up to half of the amount of water may still condense on the cooling surfaces, but the other half provides for absorption by dry containers, walls, ceiling, and floor, if needed. When the demand is less, water sprays or mist can be reduced.

Another method of maintaining high humidity is the jacket system. In this system, there is a jacket or envelop surrounding the room in which cool air circulates. Heat leaking into the room is absorbed by the flowing refrigerated air in the jacket. The main advantage of the jacketed system is that high relative humidity, approaching 100% can be maintained while condensation of water vapour in the insulation room is prevented. However, construction and operating costs of jacketed storages are somewhat higher than those for conventional storages.

Several different devices for measuring relative humidity (Figure 2.0) are available. A common instrument is a psychrometer with two thermometers. The bulb of one thermometer is left uncovered, and the bulb of the other is covered with a wick that has been wetted with distilled water. This wet and dry bulb psychrometer works on the principle that if the ambient air is not saturated, water will evaporate from the wet-muslin wick, thereby cooling the wet bulb. The wet bulb drops to a definite temperature when the heat received by convection and conduction from the air flowing over the bulb balances the heat required to evaporate the pure water on the wick. From the difference in temperatures of the wet and dry bulbs, the relative humidity can be determined from slide rules provided with the psychrometer or from psychrometric tables or charts.

Direct readings of relative humidity may be taken with hair hygrometers or gold beater's skin hygrometers. These measurements are based on the principle that organic filaments change length as a function of relative humidity. These devices are relatively inexpensive and not very accurate, especially at high humidity and they must be checked periodically for accuracy with a psychrometer. Electrical hygrometers are being used increasingly for humidity measurements and to control humidifying equipment. Operation of these is based on the ability of a hygroscopic film to change its electrical resistance instantly with small changes in relative humidity. They must be calibrated periodically.



**Figure 1.0** specially designed fogging head will put humidity only into the air, and not on the floor...

**Table 3 Relationship between relative humidity and wet bulb depression for different ranges of temperatures applicable to cold storage of horticultural produce.**

Temperature Range (°C)	Relative humidity (%)*		
	(DBT – WBT) **		
	0.5°C	1°C	2°C
0 - 5	91.3 – 92.8	83.1 – 85.7	68.2 – 71.9
5 - 10	92.9 – 94.0	86.3 – 88.2	73.0 – 76.7
10 - 15	94.1 – 94.9	88.6 – 89.9	77.5 – 80.2
15 – 20	94.9 – 95.5	90.2 – 91.2	80.7 – 82.7
20 - 25	95.6 – 96.0	91.4 – 92.1	83.1 – 84.5

\* Relative humidity values are based on psychrometric chart at atmospheric pressure

\*\* DBT-WBT = wet bulb depression where DBT=Dry bulb temperature and WBT = wet bulb temperature



**Figure 1** Instruments used for recording the relative humidity of the environment in cold store.

Commonly used humidifier in the cold stores includes:

- Spray humidifier
- Steam humidifier
- Ultrasonic humidifier

## Spray humidifier

A commonly used humidifier in the multi commodity cold store (Namdhari Seed Pack-house at Ludhiana) is shown in figure 3.0. In this type of humidifier, the water is lifted upwards on the revolving PVC discs by a centrifuge, rotating on high speed (2850 rpm). Due to high centrifugal force, the water strikes the SS atomiser grid with great impact, where the water layer is broken into ultra fine mist. The flow of air carries the droplet free aerosol/mist into the store.

## Steam humidifier

It is an electrode humidifier. It produces steam for humidification by passing electrode current through the water in the steam generator cylinder between metal electrodes. Steam output is directly proportional to the conductivity of the water (Figure 4.0), and the amount of electrode immersed in the water. On a call for humidity, the humidifier controller will open the water fill valve (1) and allow water to enter the system. A flow restrictor prevents the unit from filling too quickly or with too much

Humidifier AMOTO Engineers Pvt.Ltd Mumbai



**Figure 3** Humidifier used by Namdhari Seeds at its pack house and cold store at Ludhiana



It works on the principle of centrifugal atomization and produces droplets/mist with no wastage of water. Evaporation rate; 6 lts/hr Coverage; 60 sq ft particle size 50 micron Air circulation; 80 CFM



**Figure 4.0** Steam humidifier...



**Figure 6** Ultra sonic humidifier...

pressure. As the water fills the cylinder, it will reach the electrodes and current will begin to flow. As the water continues to fill the cylinder, the current will increase, and this is monitored by an amperage transformer placed on one of the power wires. Periodically, based on the incoming water conductivity, the unit will drain some water to reduce the mineral concentration. If there is no water in the cylinder, there will be no current flow and no steam production. The electrodes do not burn out, but they will eventually become completely coated with mineral and the cylinder will then need to be replaced or cleaned.

## Ultra sonic humidifier

These use a piezo-electric transducer to create a high frequency mechanical oscillation in a body of water. The water tries to follow the high frequency oscillation but cannot because of its comparative weight and

mass inertia. Thus, a momentary vacuum is created on the negative oscillation, causing the water to cavitate into vapour. The transducer follows this with a positive oscillation that fine mist, about one micron in diameter that is quickly absorbed into the air flow.

Since the mist is created by oscillation, not heat, the water Temperature need not to be raised. Ultrasonic humidifiers, therefore, can create instantaneous humidity, and don't have to wait for a heating element to boil the water. This precise on/off humidity control is the hallmark of ultrasonic humidifiers. In addition, unlike wet pad humidifiers, ultrasonic units can be of comparatively small size, and still produce significant amounts of vapour. When the sensors, which pick up ultrasonic humidifier has decreased below a certain level of humidity of the air ultrasonic humidifier comes into operation. When, however, capture a high degree of moisture the cool mist humidifier is turned off. In this way, it is very simple to maintain a high degree of humidity within a room as the cool mist humidifier works automatically. Main feature of this humidifier is that no mechanical drive, no noise, the output fog grain diameter only be 1-10 micron.

### Humidification requirements for multi commodity store:

Protocols set up by National Horticultural Board and adopted by other government agencies with regard to humidity requirements in cold stores are as follows: "Although higher humidity levels of 85-90% can be achieved by keeping low delta T in the cooling coil. But during loading periods and for RH>90%, humidification system is a must. Several techniques are available, but it should preferably be done using water mist with 2 - 10 micron and uniformly distributed all over the chamber ensuring that the product does not get wet."

### Conclusion

Ventilation and refrigeration in your walk-in cooler can hasten the dehydration process, robbing your vegetables of the moisture needed to maintain their freshness and appearance.

A walk-in cooler humidification system will help to prevent the 'tired' look that many vegetables can display each morning due to the effects of dehydration. Even non-misted items such as mushrooms, strawberries, and some citrus can benefit from proper RH levels, and now, new technologies have made humidification more affordable than ever.

With proper humidification, products generally last twice as long as they would otherwise, making it much easier to manage inventory and use the walk-in-cooler for the purpose it was intended. ■

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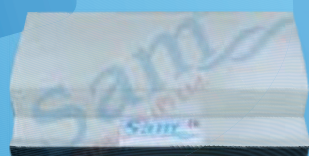
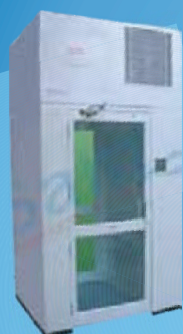


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# Importance Of Water Treatment In HVAC Systems

***Buildings consume over 20% of the world's water and HVAC systems form a bulk of the use. An effective water treatment system ensures that minimum amount of water is used in the HVAC system to obtain the desired outputs...***

**W**ater is a critical resource in building operations – it is used in a number of building systems such as domestic water systems, Drinking water, landscaping and horticulture, and the major utilities such as Diesel Generators and the HVAC system.

The quality requirements are different for different uses in the buildings and adherence to the laid down water quality is essential to ensure correct functioning of the equipments as well as to enhance the life of the machinery and systems.

While the need for quality water is understood by the operations' team, in practice, there is often not enough understanding of the water quality as well as importance of the correct water hygiene, which leads to a number of maintenance related issues, which can impact building services uptime and availability. HVAC systems in buildings consume large

amounts of water and the optimum operation of these systems is linked to the quality of the water in the system.

## **Overview of Water Quality in the Building Environment**

In a water cooled HVAC system, there are two types of water systems that are used.

### **Closed Loop Water System**

This system is used for the chilled water circulation within the evaporator and AHUs. As the name suggests, closed loop systems are not exposed to the external environment and once a system is charged, there is usually very little water that is needed to be added to the system. As the system is isolated from external contamination agents, the water quality at the time of filling up the system is critical and

thereafter only a water quality is usually maintained to reasonable levels. The closed loop system does not have problems of scale formation as there is no evaporation from the system. In addition, the system being a closed loop eliminates contact with air, which further prevents formation of microbiological contaminants in the system.

Corrosion of system pipe internal surfaces is also drastically reduced due to the absence of oxygen in the system. Care is thus required at the time of initial charging of the system and when there is need to add water due to a leak in the system or during routine draining of the system for preventive maintenance.

### **Open Loop Systems**

The condenser water system is an open loop system where water used in the condenser

is passed through the cooling tower in contact with air for cooling. Due to the external contact, there are additional challenges for water treatment and quality. The key issues that the operations team encounters related to water treatment and condition in open loop systems are presence of dissolved solids, corrosion and microbiological contamination.

### Dissolved Solids

Water evaporates in the cooling tower, which in turn increases the concentration of salts in the condenser water circuit. These dissolved solids end up as scale formation on the piping surface and condenser heat exchange surfaces. The effect of scale on the pipe surfaces is an increase in the resistance to flow, resulting in higher pumping power requirements. Scale formation on condenser tubes reduces the heat transfer and consequently the condensing temperatures increase, impacting the efficiency of the HVAC system as a whole. To offset the loss, 'make up' water is used which has a better water quality. Thus, introduction of makeup water in addition to replenishing the lost water in the system also lowers the concentration of solid particles in the system. To improve water quality, a pre-determined quantity of water is also removed from the system as 'blow down' so that the concentration of solids is reduced further. The effectiveness of the water management programme is seen in the water hardness and alkalinity of the circulating water.

### Corrosion

Various factors can cause corrosion in the piping of an open loop system. Localised Cathodic and Anodic sites form due to impurities in the metal or defects on the piping surface. The electrolyte to complete the transfer of ions from the cathode to the anode is the cooling water, hence, the quality of water is very important to prevent corrosion. Corrosion of pipes causes degradation of the metal surface and can lead to leakages – and if not checked, leads to failure.

**Micro Biological Contaminants:** Bacteria and Algae enter into the system through the open cooling tower as well as the makeup water. Interaction of these contaminants with the cooling water results in formation of slime, which creates a film over the piping surfaces. The impact of this film of slim is called fouling of the surfaces and leads to a loss of heat transfer effectiveness. In addition to fouling,

micro biological contaminants also cause corrosion, which is referred to as Microbiological Induced Corrosion (MIC), which can be more severe than the metallic corrosion. The legionella bacteria are another biological contaminants that can have serious consequences. The legionella bacteria can grow in the cooling tower water and infect humans if not treated.

### Water Treatment Program

Poor water quality has a direct impact on the effective operation of the HVAC system, leading to higher operating costs due to increased maintenance requirements and lower plant operating efficiencies. A robust water management plan is thus essential to keep the system operating at design efficiency levels as well as manage operating costs within budgets. The first step in developing a water treatment programme is to understand what 'good water' is. Table 1 lists some of the key parameters that constitute good water.

A robust water treatment programme consists of both a preventive approach and a measurement process. The key approaches used for keeping water quality to the desired levels are described hereafter.

### Corrosion Inhibition

There are three ways in which corrosion can be prevented in piping systems:

- Passive Inhibitors which form an anti-corrosive layer over the metal surface
- Perceptive Inhibitors such as Zinc form complexes, which precipitate out of the water and prevent corrosion
- Absorption Inhibitors are organic compounds that attach with the metal surface and prevent corrosion through complex mechanisms.

**Microbiological Contaminants:** Since the contaminants enter the system from the environment, the first step in control of such contaminants is to have a clean system. This includes regular draining of the system as well as effective cleaning of the cooling tower sump where the contaminants form. Chemical inhibitors are also effective in reducing the incidence of micro biological contaminants.

A key requirement of keeping this type of contaminant is to ensure that inhibitors are in the system at all times as once the system gets contaminated, removal is very difficult. Thus, a continuous dosing system is

essential to keep microbiological contaminants within limits.

**Dissolved Solids:** This type of contaminant impacts the system most as there is a direct impact on the system efficiency through scaling and increased pumping requirements. Blowdown of cooling water from the cooling tower is used to keep the level of dissolved solids to acceptable levels. The amount of blow down is arrived at based on the 'cycles of concentration,' which is a ratio of the makeup water and the amount of water bled from the system. The cycles of concentration is usually kept between 5 – 10 to keep a balanced mix between the amount of makeup water and the dissolved solids.

The blowdown can be either undertaken manually in a constant amount at laid down frequencies or through an automated system which is linked to a measurement system that measures the water hardness in the system.

### Annual Maintenance Programmes

In addition to the chemical prevention approaches, annual physical cleaning of the system is essential to clear the pipe surfaces of accumulated solids and scale. Cleaning is usually undertaken using mechanical systems or chemical solutions.

### Summary

Water is a scarce resource and it is essential to conserve water both from a sustainability point of view as well as cost perspectives.

Buildings consume over 20% of the world's water and HVAC systems form a bulk of the use. An effective water treatment system ensures that minimum amount of water is used in the HVAC system to obtain the desired outputs.

Lower blowdown leads to lesser water use, and also reduces the amount of contaminated water from going into the drain water system. Operations and maintenance teams thus need to understand that water quality is very important to not only ensure that the system works effectively – but also to reduce the impact of the HVAC system on environment. ■

**Aneesh Kadyan**  
Director - Operations  
CBRE South Asia Pvt Ltd.,  
Asset Services - India



# Interview

**" Every day, our dedicated employees turn research into reality..."**

**TSI** is quite well known in professional measurement solutions to help its customers save energy, increase occupant comfort and assure a healthy environment. Providing a complete portfolio of indoor air quality meters and monitors and ventilation test instruments, the company has set a high standard for fast, accurate and reliable test results. In an exclusive interview with **Electrical India**, **Akshay Shetty, Managing Director, TSI India Pvt Ltd**, is giving an account of their line of business and environment to **PK Chatterjee**. Excerpts...





**Q** What kind of potential are you finding in the Indian market as far as TSI's business growth is concerned?

**A** In the last 4 years TSI India has been growing at a CAGR of more than 20% and we do believe that we would continue to grow at the same rate. We have some products which require approvals from government organisations helping us to increase the market opportunity. Paris agreement along with the growing awareness of pollution related harmful health hazards, energy conservation should help us to get our products approved, which can accelerate the growth to more than 30-40%.

**Q** Please tell me in brief about your business model in this sub-continent.

**A** We have various products portfolio. For products which find applications in the research and analysis domain, we sell directly to the customers. Products which find applications in HVAC, clean rooms in pharmaceutical companies, industrial hygiene, respiratory fit testing and exposure monitoring, we sell through our channel partners. We have more than 10 channel partners in various regions of the country.

**Q** What kinds of technologies are you offering in India?

**A** Our products work on the state-of-the-art laser based optics, light scattering technique, laser photometer and spectrometer technology using which real time precision measurements can be done.

**Q** Which are your most targeted sectors?

**A** Our most targeted sectors are comfort and cleanroom HVAC, indoor and outdoor environmental monitoring and research, medical equipment, automotive emission testing and research, aerospace research, industrial hygiene, respiratory protection and agriculture.

**Q** How is your support to the Indian HVAC&R industry in particular?

**A** Our products provide high accuracy real time measurements for maintaining optimum building HVAC performance and indoor air quality compliance, thereby ensuring energy efficient buildings and healthy workspace.

**Q** What will be the impact of the Paris agreement on your business?

**A** Paris agreement focuses on reduction of carbon emission, which means improved energy efficiency, need for greener buildings, thereby increasing demand for high accuracy HVAC testing products.

**Q** Who are your major clients here at present?

**A** Our major customers are HVAC contractors, pharma and healthcare companies, environmental research institutes, oil and gas companies, respirator manufacturers and facility managers.

**Q** What're your plans to expand TSI's business further in India?

**A** We plan to expand business in India by reaching out to untapped markets and applications by strengthening our distribution network.

**Q** What would you like to communicate to your potential business partners?

**A** TSI Inc. serves a global market by investigating, identifying and solving measurement problems. As an industry leader in the design and production of precision measurement instruments, TSI partners with research institutions and customers around the world to set the standard for measurements relating to aerosol science, air flow, chemical analysis, indoor air quality, fluid dynamics, biohazard detection, and even scrap metal sorting and plastics identification. With headquarters based in the U.S. and field offices throughout Europe and Asia, TSI has established a worldwide presence in the markets we serve. Every day, our dedicated employees turn research into reality. ■

# A Versatile Eco-friendly Solution For All Industries



***Recognising the challenges faced by the water sector, stakeholders from academia, corporations and the engineering sector have developed some water intelligence tools to improve global water issues...***

The water chain (water reserve, production, distribution, consumption, collection and treatment of waste water) play primary role of the urban system, influence all pillars of the urban society and its functionality, sustaining populations, generating energy, supporting tourism and recreational activities, ensuring environmental and human health, and fuelling local economic development. Such increasing convergence fosters urban growth, as more than half of the world's population currently resides in urban areas.

Smart Water Management is close loop of water resource development and environmental protection, and it also requires proper management of the demand for public services. Subsequently, civic water management must ensure access to water and sanitation infrastructure and services, manage rain, waste and storm water as well as runoff pollution, mitigate against floods, droughts and water borne diseases, while at the same time safeguarding the resource from degradation.

In today's integrated global economy, innovations in Engineering have created a valuable opportunity to address these water challenges within cities, whilst improving urban water management.

Recognising the challenges faced by the water sector, stakeholders from academia, corporations and the engineering sector have developed water intelligence tools to improve global water issues.

The role played by smart water systems in optimising the efficiency, effectiveness and flexibility of water and wastewater infrastructure assets and their management constitutes a topic of increasing attention.

Smart water management technologies are currently applied to many different areas of water management.

Major tasks for smart sensor networks in water quality monitoring include the following:

- Identify and characterise changes in existing surface water quality over time.
- Collect information to design in a timely manner to allow quick response to problems.
- Determine agreement with pollution regulations or implementation of effective pollution control actions.
- Integrating smart pipes and sensors within

the urban system enables key functions such as the detection of events based on the monitoring of flow rate, pipe pressure, stagnant points, slow-flow sections, pipe leakage, backflow, and water quality to be monitored, which constitute data needed to optimise the operation of current networks.

### Advance Smart Energy Enhancer-4M

100% ideal as well as cost effective solution does not exist in the world, so why we should not adopt Eco- Friendly Technology with Fit & Forget Solution.

"Advance Smart Energy Enhancer-4M" is a Micro Controller-based Electronic and Electrical Device. It contains multiple technologies in one single device for physical water treatment system for all purposes.

- With the help of Advance Smart Energy Enhancer there are ample opportunities to increase Energy Efficiency.
- With very little one time investment & retrofitting gives 80-90% improvement in your routine water consumption and maintenance with or without expensive softener plant.
- Makes Smart & Green HVAC & Refrigeration system.

### Ecofriendly system because it indirectly reduces wastage of water

- Reduce rate of cleaning or replacing filters in heat pumps & membranes in R.O. system.
- Reduce rate of Chemical Dosage in Cooling Tower, Water softener in Swimming pool.
- Reduce Maintenance due to improved water quality used in industries for various applications like Heating, Cooling, Cleaning, Steam generation, Heat pump, Feed water pump and many more applications.
- Improve Health of Human, Cattle, Chickens as well as Luxuries Equipments Capital cost in Buildings.
- Reduce Maintenance as well as routine cost spent in Resort, Spa and Hotels (i.e., Kitchen, Laundry, Toilet blocks, Gardens, Swimming pool, solar heater Elements, PNG Consumption and Waste Disposal plant).
- Beneficial for obtaining Green point rating in All Five Star Hotels/ Luxurious Hotels through Smart E-Water Management System.
- Save Money, Manpower & Machine.
- Reduce Routine Maintenance up to 60-70





% in esteemed resorts, hotels and industries.

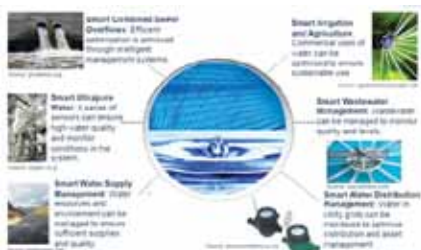
- Solve hard water problem with very little one time investment for life time.

## About performance

Innovative, Green and Eco-friendly Products for your Esteemed, Industries, Resort, Hotels for Getting Green Point Rating and Reduce your Maintenance due to water in Various Process involved with All Industries. Energy Enhancer gives Double benefits i.e., Combined Effect of Electronics Descaler & conventional water softeners; after just 2-3 months observation you feel water quality improved day by day.

Water preserves its natural healthy minerals. Unattractive stains on basins, wash bowls and sanitary ware will be very easily wiped away with less effort.

- Hot water system will heat up faster.
- Reduce drastically in the rate of blocking pipes and shower heads.
- Dishwashers, washing machines, kettles



Source: Hauser (1)

and other water fed appliances operate efficiently.

- Soap and detergents produce less scum and work more effectively.
- Clothes retain softness and colour.

## Advance method

- TDS measurement and reduction is not an actual parameter for above all problems, so by reducing TDS with softener plants not fulfilled your maintenance problems and energy efficiency problems and also increases wastage of water – not considered as an “Eco-friendly” system.
- If we use-Maintenance Free “ Advance Smart Energy Enhancer-4M,” which convert high quality water same as soft water without changing its chemical composition but converting its physical property and breaks  $\text{CaCO}_3$  and makes them neutral, and diminishes its adhesive

property, which are the main causes of deterioration of water quality and creates lots of problems, this device gives feeling of soft water, very cost effective solution for making quality water and saves lots of running expenses in day to day routine water requirement.

- 30-40 % Less Detergent/ Soap /Powder consumption for cleaning & creating more foam with less water. Reduces routine expenses (i.e., need less make up water indirectly saving electricity spent for running submersible motor pump (30 minutes instead of 60 minutes to fill water tank, saves energy, saves environment by reducing waste water )
- Gives extra Silky Feeling of Clothes and Maintain Original Quality of Fabrics, Original Natural Shinning of Cotton and Fabrics, Increase life of Curtain, Bed sheets, Towels, Uniforms of Chef's and servants as well as guest or customers' clothes in luxuries hotels and hostels and international schools.
- Moreover, your washing machines or laundry for hotel or hostel also work with high efficiency because of scale free high quality water so jamming or cogging of shaft in washing machine is common problems after 2-3 years will also reduce drastically, ultimately it becomes maintenance free and saves indirectly

energy as well as environment.

- "Advance Smart Energy Enhancer" is a Green & Eco friendly Smart way to get rid of lime scales in water pipelines. Newly developed technology eliminates scales in pipelines effectively. Powerful Advance Smart and Combination of Technologies gives almost six times more effect than available all models of electro-magnetic water conditioner in local or international markets.
- "Advance Smart-Energy Enhancer" is world's most powerful. No chemicals are used and it is maintenance free - 20 + years of Device Life.
- This Innovative Device removes scales by natural process step by step and reduce rate of formation of new scale buildup in your machines.

## The product is superior over traditional methods. How?

- Ion-Exchange - Limitations of this method is: you have to maintain systems with
  - i) Exchange Resins and
  - ii) Salt - Needs lots of running expenses and increased salt level in water leads lots of
- Health Related Diseases not suitable for Heart Patient.
- Phosphates - Limitations of this method is: you have to maintain system with Poly-phosphate crystals - Needs lots of running





expenses.

- Permanent Magnets - Limitations about the results - Few customers are satisfied and few are not sure about results not effective for Changing Property of water Hardness and Higher TDS .
- Advance Electronics & Magnetic based De-scaling technology
- Advantages are manifold but still take more time 6 to 8 Months for cleaning your all old systems:
- With Energy Enhancer: Same effect will observe within 45-60 days and six times more powerful than all conventional devices because of geographic location, and site specific customize design and one can change its parameters under expert guidance with frequently changing hardness year by year, so one device works for entire life.

### What are the common benefits observed after installing "Advance Smart Energy Enhancer -4 M"

- Reduced energy consumption to Generate Steam & Warm the pool with Fresh water.
- Filter /Membrane Life Increase up to 60%.
- Reduce the use of chlorine dosage up to at least 35%.
- Reduce turbidity even with reduced need for filter cleans.
- Softener Plant refilling Maintenance reduces up to 70%.
- Remove scum deposits from the pool edge.
- Maintain stainless steel fittings to their original condition.
- Remove lime scale and later bacteria from within the swimming pool plant.

- Reduced need for chemicals to maintain pH balance.
- Additional savings in energy, chemicals and water are possible.
- TDS (Total Dissolved Solids) levels can be maintained at a higher level than usual if calcium is no longer precipitating out as scale. Therefore, periods between back-washing filters can be extended, subsequent in less water and chemicals being emptied down the drain.
- Reduce maintenance in water fountain Jet, Jacuzzi should be cleaned at regular interval for its effective patterns.

### In five star hotels kitchen, laundry and solar heater or any water heater bath rooms and water heaters

- No Hotel or resort Luxuries Bungalows and Villas found without expensive state of the art Swimming Pool, Luxurious Bathroom, Bathtub, Expensive Glamour's Shower and Taps, Neat and Clean stain free and Germ free Toilet Blocks.
- most common problem in all hotels and resorts are due to hard water all utility equipment's needs regular cleaning with acidic treatment or any other cleaning chemicals otherwise white spot and lime scale layer spoil its pleasant exterior. Additionally, acidic treatment reduces device life's and it is not a green, Eco friendly and desirable methods.
- For heating or warm up of swimming pool needs heaters, because of hard water boiling time increases as well as heating element also corrode or if one can use solar water heater then also inside the tank heat exchanger coil will also get damaged due to corrosion and scaling after 3-5 years. That means reinvestment in capital equipment without using its exact life span.
- With Energy Enhancers, above all sectors save lots of running expenses spent behind softener plant, refilling of salt and resin and descaling acidic treatment for routine cleaning of kitchen ware indirectly saves water, energy and environment also.

### In laundry / washing machine

- In well reputed hotels and resorts for cleaning and disinfection of clothes needs lots of hot water.
- Engineering departments or utility

department used conventional methods like bore well water after that installed water softener plant for converting hard water in to soft water and passed through boiler and convert in to super saturated steam for cleaning.

### Disadvantages are

- Lots of running expenses and maintenance for refilling of resin or salt with regular interval.
- In boiler due to hard water scale deposited inside water tubes, which reduces heat transfer capacity, because of lime scale layer formation, which acts like an insulating layer and increase fuel consumptions and need more time to heat up & feed water to boiler.

### If you use Advance Smart Energy Enhancer – an electronics & micro-controller based technology, advantages are manifold

- Guaranteed satisfaction on performance.
- No use of chemicals - running expenses saved.
- "FIT & FORGET"- Maintenance-free device.
- Life: approx-20+ years

### Conclusion

Adopt Smart Technology with Existing Water Purification Methods, 100% perfect technology does not exist in any Engineering Field, implements new technology for your application, bypass your conventional methods and observe if you achieve minimum 60-80% saving in maintenance cost & efficiency increases 10-20%, then also it is worthwhile because it leads to big savings in routine water consumption.

Save water, save environment and reduce wastage of water. ■

#### Prof Gaurang Sharma

Ass. Professor  
Birla Vishvakarma  
Mahavidyalaya  
Vallabh Vidyanagar



#### D. A Suthar

Chief Project Executive at  
Advance Magnetronics –  
Emerging R & D Institute



# OEMs To Receive Boost From SIEMENS

*A special focus for Siemens at Mostra Convegno will be its digitalized solutions and systems for Original Equipment Manufacturers (OEMs)...*

**M**CE – Mostra Convegno Expocomfort will celebrate its 40<sup>th</sup> edition confirming itself as the undisputed leading exhibition in Global Comfort Technology. The trade show, to be held from March 15 to 18, 2016 in Milan, will give Siemens a platform for presenting its comprehensive portfolio of energy-efficient products for the Heating, Ventilation And Air Conditioning (HVAC) market. As a single-source supplier, the Siemens Building Technologies Division will exhibit a broad palette of products and solutions under its trade show motto 'Power up your efficiency,' including powerful products for HVAC systems, compact and communicative field devices, the intelligent Climatix IC remote servicing system and the innovative Desigo CC building management platform.

A special focus for Siemens at Mostra Convegno will be its digitalized solutions and systems for Original Equipment Manufacturers (OEMs). "The Climatix IC remote servicing system and our communicative field devices for HVAC plants give our OEM customers the opportunity to set up efficient workflows during the design, manufacturing and commissioning phase. They also save time and money during operation and maintenance. By boosting the productivity and flexibility of our OEM customers and affording them greater efficiency and more time for their business, we give them a significant head start in their economic and ecological competitiveness," explains Reiner Werner, Head of Field Devices & OEM at Building Technologies.

At Mostra Convegno 2016, Siemens will show its innovative cloud-based remote servicing system for heating, ventilation and air conditioning plants. This solution continuously collects all important process and plant data over the entire life cycle and stores them in a central location. This information not only makes it possible to analyse system status, reliability and efficiency – but also prepares for diagnostics, optimises values and performs upgrades – by remote



access and without requiring a technician on site. Climatix IC now also provides a geographical overview of all connected systems and the status of each. This gives technicians a quick overview and allows them to set priorities and plan pending service calls efficiently. Climatix IC offers customers superior flexibility, promotes efficient servicing of supported systems and simultaneously cuts the costs per service call.

Building Technologies rounds out its range of communicative products for HVAC plants with an array of new field devices.

- The Climatix Controllers 400 and 600 are embedded in a flexible, scalable hardware concept and come with preloaded and tested applications for use in less complex HVAC plants. For more complex



plants, this automation solution is available as a freely programmable option. Special software supports OEMs engineering, plant programming and commissioning.

- The new communicative actuators for air dampers and control ball valves make production more efficient for OEMs. Wiring work and risk of errors are minimised, with no need for time-consuming troubleshooting of the equipped HVAC plant.
- As yet another key HVAC plant component, the comprehensive Symaro range features precise and robust sensors for temperature, CO<sub>2</sub>, pressure and humidity for more energy-efficient operation.

The new 6-way control ball valves, which Siemens will debut at Mostra Convegno, represent an important addition to its Acvatix valve family. Because of its special design, a 6-way control ball valve replaces four conventional valves (including actuators) and, thanks to a single

actuator, occupies only one data point. Less effort for installation, commissioning and cabling as well as decreased space requirements significantly reduce the complexity of the plant and result in lower costs.

Finally, Siemens will also highlight its Desigo CC building management platform, which consolidates the management of all building disciplines in a single system. Thanks to a number of supported communications protocols, including BACnet, SNMP, Modbus, SSL and OPC, third-party products are easily integrated into the open platform. The flexible and intuitive user interface can be customised as needed and adapted to the roles, rights and language of each user. The platform offers powerful analytics, which greatly facilitates troubleshooting, error correction and performance optimisation of specific disciplines. In addition, a new Desigo CC app offers mobile remote access to building automation and alarm management. ■

## 4 Significant Proposals To Mitigate Climate Change

As per Lima-Paris Action Agenda (LPAA), a profound renewable dynamics is spreading to all countries in the world, with regions working to leapfrog to clean energy. The business case for renewable energy has never been stronger. Renewables are now the most cost-competitive sources of power in many parts of the world and renewable power accounted for more than half of all capacity additions in the global power sector since 2011. Actions on these fronts are well underway...

Several initiatives have been launched at the COP and LPAA Energy day at the Paris Climate Summit, to accelerate this dynamics. Four significant proposals are:

1. The Global Geothermal Alliance (GGA), launched is set to achieve a 500% increase in global installed capacity for geothermal power generation and a 200% increase for geothermal heating by 2030. The world contains vast geothermal energy potential, proven across nearly 90 countries. But almost 90% of this remains untapped with roughly 12 GW installed so far. What was an idea just over a year ago, the GGA is now a strong partnership of 36 countries and 23 institutions with the action plan in place to meet the set goal.

2. India elaborated on its recently launched International Solar Alliance (ISA), which aims to align countries with the abundant solar potential to push the development of solar energy technologies. With the focus on accelerating the deployment of solar energy in developing countries, the alliance will work to meet the multiple objectives of access, economic prosperity and sustainable growth. The transformation potential of the Alliance lies in its prospective membership of over 120 countries of Tropic of Cancer and Tropic of Capricorn.

3. The Africa Renewable Energy Initiative (AREI) has announced its ambitious plans for deployment of renewable energy in Africa: build at least 10 GW of new and additional renewable

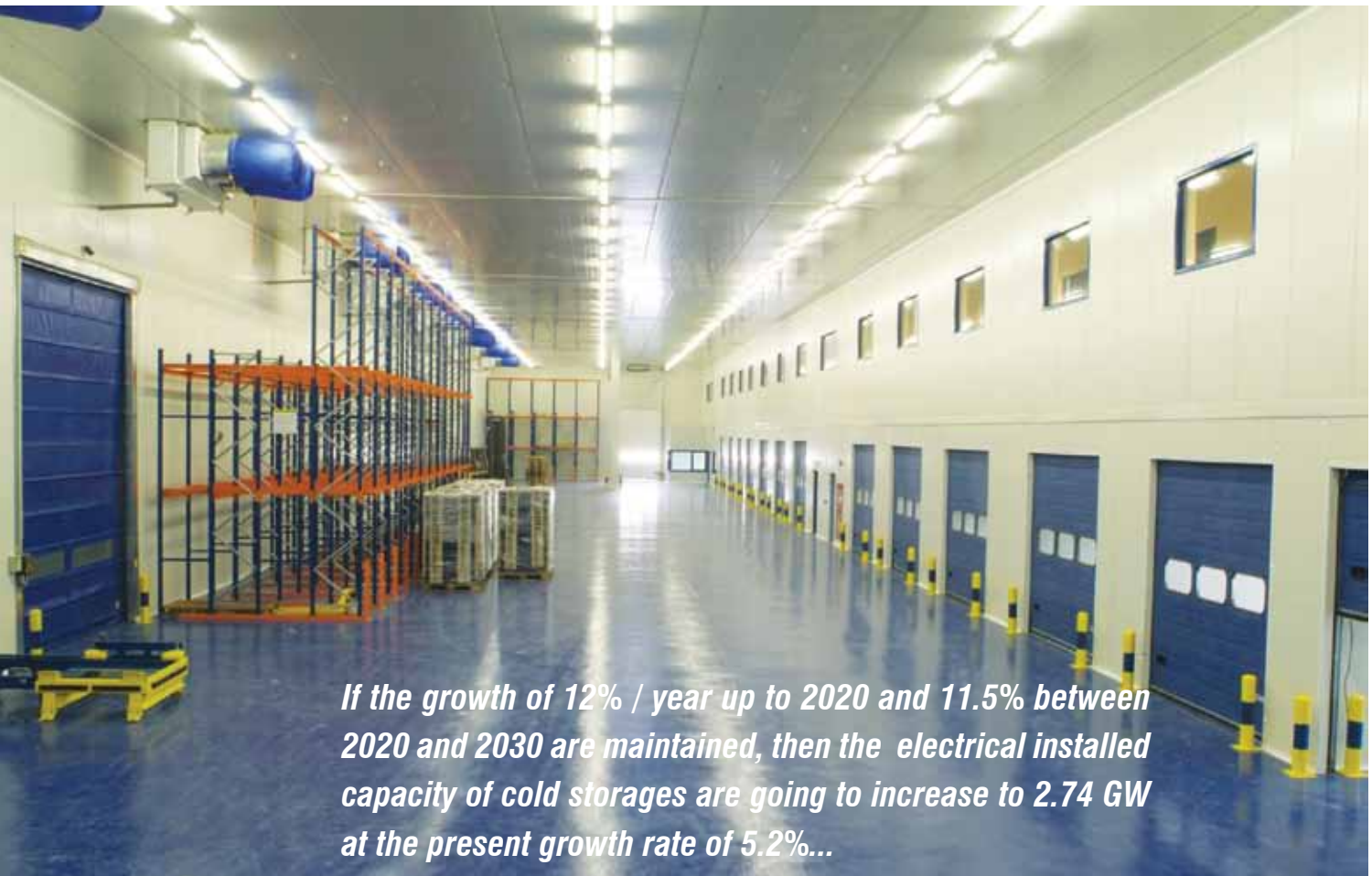


energy generation capacity by 2020 and 300 GW by 2030. Considering that current total electricity generation in Africa is roughly 150GW this is a massive contribution to the climate change effort by the region. The Energy Day featured the forging of a range of partnerships to help meet this ambition.

4. The Africa Clean Energy Corridor has demonstrated progress and announced the beginning of similar work in the West Africa power pool.

Clean Energy Corridors are regional platforms to accelerate deployment of renewable energy in larger region – thanks to economy of scale and optimisation of resources. Regional planning, capacity building, regulation convergence and tapping and connecting the best potentials are at the programme of these partnerships. Combined electricity demand in the Eastern Africa and Southern African power pools could exceed 1000 terawatt-hours by 2030 – more than double their 2010 power consumption. Renewable energy can help meet this rising demand and drive Africa's rapid economic growth without adding to global climate risks. ■

# Powering Cold Storage Plants



*If the growth of 12% / year up to 2020 and 11.5% between 2020 and 2030 are maintained, then the electrical installed capacity of cold storages are going to increase to 2.74 GW at the present growth rate of 5.2%...*

Presently, Indian's cold storage capacity is 30 million tonnes (7000 individual cold storage units), accounting for 1.2 GW or 0.5% of the installed electrical capacity and 6.7% of the gross produce. A comfortable cold storage coverage for India is 20% of the produce requiring a growth rate of 12% up to 2020 to achieve a capacity of 70 million tonnes (2020) and subsequently 11.5% up to 2030 to achieve 200 million tonnes (2030).

The corresponding electrical load in 2020 would be 2.74 GW and in 2030 would be 7.8 GW.

To achieve this level of cold storage capacity, first of all, the issues of weak conventional grids (frequent power disruption, power fluctuation and power cuts) must be addressed through renewable power (solar photovoltaic).

Also, the energy efficiencies (kWh/m<sup>3</sup>/year) for Indian cold storages (majority working on ammonia as refrigerant) for chilled systems (0 to 10 °C) and refrigerated systems (-18 to -25 °C) need to be brought on par with international practice through reinforcement of insulation, containment of infiltration, efficient controls and retrofitting with solid state variable frequency drives for major motors.

This article discusses the cold storage units to powered by solar

photovoltaic (SPV) with ice cum refrigerant (low pressure ammonia) storage for units of standard Indian economical capacities 5 kilo tonnes. Major issues with energy supply to the cold storage units are reliability of power and shortages for few hours at a stretch. This would involve development of alternative energy sources, viz., solar photovoltaics (SPV) along with storage systems for powering of the cold storages.

Typical power utilisation pattern of cold storages is that there is initial power for reducing the temperature of the cooling space and the products stored down to the required level. Once the steady state cooling temperature is reached, then the power requirements are reduced only to top up power which is very low.

SPV with ice storage is an ideal solution for the Indian conditions for powering the cold storages. While on the financial side, additional capital cost is involved for installation of the autonomous power system for the cold storage, this will relieve the system of grid power and the outages associated with the grid.

Coupled with the renewable power the top up power needs to be minimised through good level of insulation, temperature control and automatic control of the power source.

## Cold storage in India

Cold storage is a sure solution to the problems of wastage reduction in the food sector. The various measures of Govt. of India and public-private participation has contained the wastage to 5.8 % for fruits and 18 % for vegetables. Being the largest producer of fruits, largest producer of milk and second largest producer of vegetables in the world, India is having a growth rate is around 3-5 % per annum for various products. The present production is given in Figure 1.

The cold chain, as it is called, is centered around cold storages for short term storage of products of agricultural, horticultural, poultry, fishery, dairy etc.

Cold storages are an important vehicle for conserving and value addition of agricultural products. Banks encourage cold storages wherein 70% capacity is available on rentals to farmers and rest for own use.

A typical Indian cold chain consists of the following:

- Past harvesting packing
- Transfer to cold storage facility
- Pre-Cooling
- Cold storage
- Chilled / Refrigerated transfer
- Packing
- Distribution
- Sale

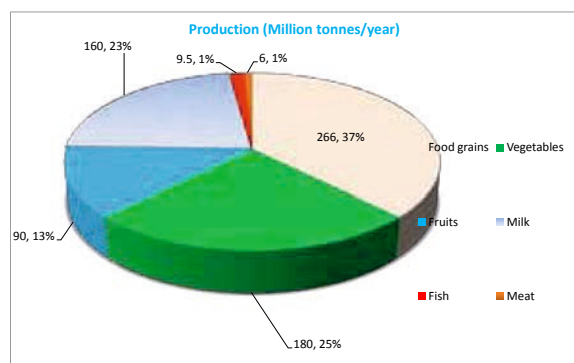


Figure 1 India's food production for 2013

The cold storage network business is estimated at Rs. 33,000 crores of which 85% is accounted by cold storages and 15% by transportation. The growth rate prospects are high because of good

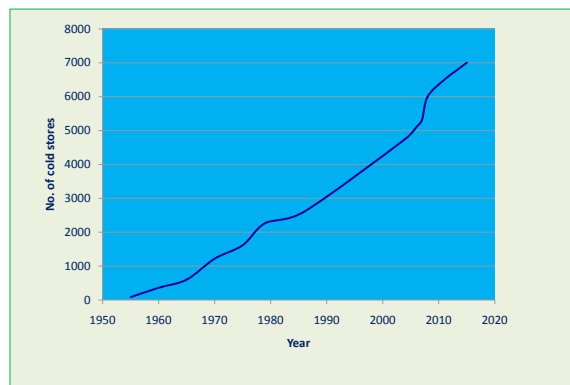


Figure 2: Growth of the number of cold storages in India...

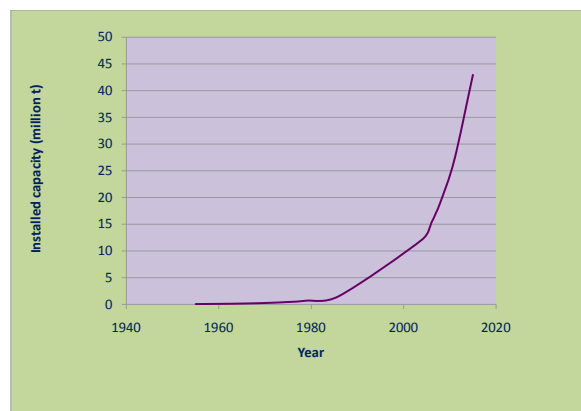


Figure 3 Installed capacity of cold storages in India.

incentives (51% for FDI). Sector wise, 95% of the cold storages are in the private sector. Product wise, nearly 90% of the cold storages are catering to storage of potatoes. Zone wise, over 50% of the capacity is located in the Northern zone. State wise, UP and West Bengal account for over 60% of the capacity.

Figures 2 and 3 give the growth of number of cold storage units and cold storage capacity in India (data for 1955 to 2009). Presently the installed capacity is 27.7 million tonnes with 6500 nos of units.

The growth rate in reference to the 1955 base level index is around 12.1% / year. However, with reference to 2004, the growth is only 5.2% / year. The growth is almost dovetailing with the product growth indicating that additional percentage capacity addition is not being added.

The processing capacity needs increasing acceleration. Presently it is nearly 7% of the gross produce. India will be in a comfortable position if this is increased to around 20% / year of the gross production in near future through various policy interventions and special purpose vehicles.

To achieve this, the growth rate of cold storage capacity has to increase at the rate of at least 12% per annum up to 2020 and subsequently 11.5% / year up to 2030 as shown in Figure 4. At the present rate of growth of 5.2 %/year cold storages will grow to 40.5 and 67.2 million t by 2020 and 2030 respectively. If the 12.0% or 11.5% growth rate is achieved, cold storages will grow to 66.85 million t by 2020 and to 199.77 million t by 2030. The corresponding electrical load in 2020 would be 2.74 GW and in 2030 it would be 7.8 GW.

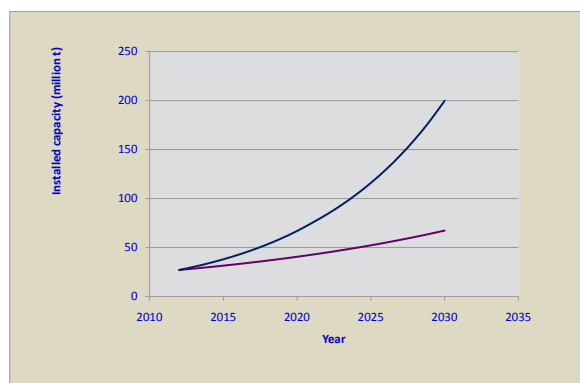
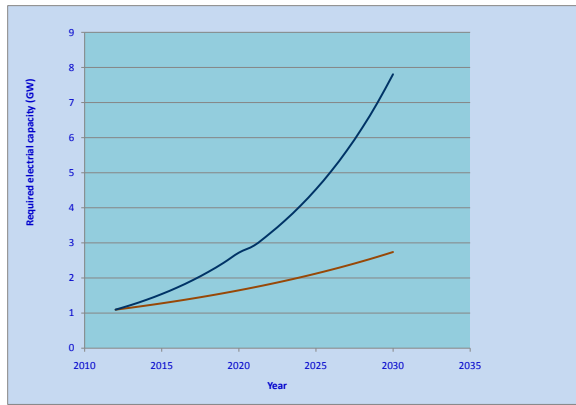


Figure 4 Project growth of cold storage capacity at present rate (5.2%) and required rate (12.0%).





**Figure 5 Projected growth of electric capacity due to cold storage units at present rate of growth (3%) and required growth rate (5.2%).**

Cold storages are accounting for nearly 1% of the electric power generation in France and a slightly lower number in many European countries, US and Latin American countries. In India, it is 1.1 GW (1100 MW) accounting for 0.5% of the installed capacity (presently 220 GW). If the growth of 12% / year up to 2020 and 11.5% between 2020 and 2030 are maintained, then the electrical installed capacity of cold storages are going to increase to 2.74 GW at the present growth rate of 5.2%. Figure 5 gives the increase in electrical load on account of cold storages until 2030.

## Types of cold storages

The following categories types of cold storages are popular in India:

- Small cold storage (export oriented)
- Frozen foods (refrigeration)
- Ripening chambers for fruits

The National Horticultural Board of Govt. of India has classified the cold storages into the following categories:

- Bulk cold storages for storage of fresh horticulture products which do not require pre-cooling
- Multi-commodity cold storages for short term and long-term storage of fresh horticulture products, which require pre-cooling and varying storage requirements
- Control Atmosphere Storages (CAS)

The technical standards and protocols have been brought out to facilitate growth of cold storage capacity in India.

The commonly used cold storage designs (based on production of cooling effect) are:

- Coils at the top (bunker type)
- Floor mounted air conditioning unit with diffuser type coils at various heights
- Plate and fin coil type air conditioning units with sandwich panel construction

Of the three, the first is of the oldest design and the third is of the most modern design with best energy efficiency.

Based on temperature of the cooling space, mechanical refrigeration equipment can be classified as:

- Class A (+ 12 °C and 0 °C)
- Class B (+ 12 °C and - 10 °C)
- Class C (+ 12 °C and - 20 °C)

- Class D ( $\leq 0$  °C)
- Class E ( $\leq - 10$  °C)
- Class F ( $\leq - 20$  °C)
- Pre-cooling reduces the cold storage load brings in uniformity and improves product utilisation efficiency (reduction in wastage). The following options are available for pre-cooling cooling in cold storage units:
- Ceiling air coolers (located inside cold storage)
- Floor mounted air coolers (located inside cold storage with ducts at the top)
- Insulated air coolers (located outside at the top side with air ducts inside the cold storage)
- Insulated air coolers (located outside at the top side without air ducts)
- Air curtain type air coolers (located at one end inside the cold storage without any ducts)
- Penthouse mounted insulated air coolers (mounted above at the centre)

The majority of the cold storages (95%) fall in the range of medium temperature or frozen as:

- Medium temperature products: 0 to 10 °C.
- Frozen products: -18 to -25 °C.

The working fluid in the majority of the systems (> 98 %) is presently ammonia (R717).

The efficiency of the air circulation system is determined by the temperature difference between the coldest and warmest zones which must be within 2°C. Stratification or sectionalisation of temperature indicates poor air circulation.

Sl. No.	Particulars	Units	Values
1	Volume of cooling space to weight conversion	m <sup>3</sup> /t	2.2-3.4
2	Air circulation before set point is reached	m <sup>3</sup> /h/t of product	160-170
3	Air circulation after set point is reached	% of design capacity	20.0-40.0
4	Cooling capacity	TR/1000 m <sup>3</sup>	2.80-4.0
5	Margin in design cooling load	%	10.0-30.0
6	Ventilation air changes per day before set point is reached	no./day	6.0-8.0
7	Ventilation air changes per day after set point is reached	no./day	1.8-2.0
8	Operating period before set point is reached	h	16.0-18.0
9	Operating period after set point is reached	h	8.0-10.0
10	Loading rate of new product for cold	% of total capacity	4.0-6.0

**Tab e 1 Basic parameters of cold storages.**

The core technology for refrigeration of cold storages is the vapor compression systems. Vapour absorption systems though becoming popular and limited in their number of installations. Depending on the arrangement in the cold rooms, three types of popular compression systems are:

- Diffuser type: for low heights
- bunker type
- Fin coil type

Based on the energy source and operational principle, cold storage systems can be classified under the following sub-systems:

- Source power plant - grid electrical power, captive diesel electric power, Renewable Solar Photovoltaic (SPV) or wind electric power, thermal power from process steam, solar concentrating collectors, etc. In the case of diesel back up for vapor compression systems, the energy consumption is nearly 0.3-0.35 litres/kWh of electric power generated. The flue gases are let out at 400-450°C without any application.
- System power plant – Vapour Compression System (VCS)-reciprocating / screw compressors, Vapour Absorption System (VAS). The basic parameters of cold storages in India are given in Table 1.

### Size of the units

The sizes of Indian cold storage plants are generally given on the basis of weight (tonnes of product processed) whereas in Western countries the sizes are given volumetrically (m<sup>3</sup> of cooling space). The conversion rate between weight and volumetric basis varies between 2.2 to 3.4 m<sup>3</sup>/t. Typically the conversion factor is 3.4 m<sup>3</sup>/t.

This must not be mistaken with density but is a form of bulk density including space for housing of evaporator coils, air circulation and physical movement for navigation inside the cold storage etc..

The 5000 t (17000 m<sup>3</sup>) is considered as an economical size for Indian conditions. The largest size of the Controlled Atmosphere Storage (CAS) is around 20 kt while that of refrigerated cold storage is 12 kt.

### Operational mode and energy consumption

While in western countries cold storages are operated all year round (8760 h/year), in India majority of the cold storages are seasonal for short term storage of food products. The operational cycle is around 4-6 months.

The annual operation of cold storages in India can be classified as:

- Peak period (high energy consumption)
- Holding period (medium energy consumption)
- Lean period (low energy consumption)

Gurmit Singh (2010) has brought out the performance of cold storages under the three different conditions of operation. The peak pull down period is dependent on the loading rate which is normally 4-6 % of the total capacity. Typically, a 5% loading rate (of the total capacity) gives a peak period of 20 days.

The characteristics of the cold storage during the three operating phases are given in Table 2. Usually a larger capacity is selected for achieving faster pull down but the part load efficiency will be poorer, if the capacity control at part load is not through solid state load controls.

If the capacity control is achieved through cylinder unloading no substantial savings can be observed during the holding and lean periods.

The energy consumption during the peak period is dependent on the

Sl. No.	Particular	Units	Pull down period	Holding period	Lean period
1	Period of operation	months/year	0.67	1.5	6
2	Hours of operation per day	h/day	20	18	12
3	Cooling load (approximate)	%	100	40	20
4	Electrical power loading (approximate)	%	100	50	30
5	Specific power	kW/TR	1.18	1.46	1.86
6	Cooling capacity	TR/1000 m <sup>3</sup>	6.73	2.63	1.31
7	Electrical power	kW/1000 m <sup>3</sup>	7.95	3.84	2.45
14	COP	imensionless	3.8	3.4	2.6

**Tab e 2 Characteristics d ring the three p ases of op ration.**

condition of pre-cooling. Pre-cooling (from ambient conditions to the vicinity of 0 °C) can bring down the energy consumption during the peak phase of cooling. The various methods of pre-drying are as follows:

- Forced-air
- Hydro
- Vacuum
- Water spray
- Ice
- Room

Of these the hydro drying and forced air drying are most successful and energy efficient as they are of low energy intensity involving fan power in place of compressor power. Forced cooling (induced draft) can be achieved at 2.5-4.0 m<sup>3</sup>/s per tonne of product.

The breakup of the thermal cooling load is accounted for by the following factors:

- Transmission through walls, roof and floor
- Product heat generation
- Internal electrical heat generation
- Infiltration
- Defrost heat generation (removal of ice from evaporator)
- Design margin

In well designed systems, the heat transmission, internal electrical generation, infiltration and defrost heat generation must be minimised to the extent possible. If ice is formed over the evaporator, then it will retard the cooling capacity resulting in loss of energy efficiency.

The energy consumption during the holding and lean periods is dependent on the status of insulation, air tightness (infiltration / ingress of into the system) and the operational temperature controls. In the event of these factors being good, the on time to total time ratio of the refrigerant compressors will be reduced thereby not only reducing the energy consumption but also enhancing their life.

### Specific energy consumption

Specific energy consumption (SEC) = annual energy consumption/ volume of cold storage in kWh/m<sup>3</sup>/year. This is the standard energy efficiency index used internationally. In the case of India, where the

operation is seasonal, the monthly consumption is extrapolated to annual value to obtain comparative results of deemed SEC. The SEC is dependent on the installed characteristics of the system especially the heat gain from various sources (useful and not-useful), minimisation of situations of defrosting etc. The on time to total time ratio of the system is purely dependent on the thermal ingress in the system.

The SEC can be broadly classified for two types of systems:

- Chilled: 0 to +10 °C
- Frozen: -18 to -25 °C

The SEC (kWh/m<sup>3</sup>/year) is given for refrigerated units by Paul Singh for USA data by the fit,

$$SEC = 1369.3V^{-0.2275} - 5.56$$

Vis the volume of the cold storage space in m<sup>3</sup>.

The SEC of chilled storage systems is given in Table 3 and those of refrigerated systems are given in Table 4. Figure 6 gives the frequency distribution of SEC of cold storages in Europe. In Indian conditions where

Sl. No.	Chilled cold storages (0 to +10 °C)	SEC (kWh/m <sup>3</sup> /year)
01	Europe range	30-125
02	Europe average	43.5
03	US range	30-52
04	US average	33.5
05	South Africa (2005)	53.5
06	South Africa (2012)	37.62
07	Netherlands	30-110
08	India (pull down period)*	47.7-63.5
09	India (holding period)*	46.1-62.7
10	India (lean period)*	35.0-54.8

**Tab e 3 SEC of chilled storage systems.**  
**ā emedn nual consump ion**

Sl. No.	Frozen cold storages (-18 to -25 °C)	SEC (kWh/m <sup>3</sup> /year)
01	Europe range	50-425
02	New Zealand, UK & US [8]	40-140
03	USA best practice value	30-60
04	US Refrigerated warehouses (1997)	56.20
05	US Refrigerated warehouses (2012)	32.30
06	UK	99-124
07	Netherlands	50-325
08	India (pull down period)*	50-100
09	India (holding period)*	50-70
10	India (lean period)*	40-60

**Tab e 4 SEC of refrigerated storage systems.**  
**ā emedn nual consump ion**

there are no all year round operations the annual data must be extrapolated from the experimental values of 3-4 months to 8760 hours/year. This is termed as deemed energy consumption.

It has been shown from various studies that the ambient temperature variations do not significantly affect the all year round energy consumption. The data indicates that the SEC of Indian units are far too high on account of thermal insulation and infiltration. The low values in few cases are due to factors like unscheduled power cuts which cannot be considered on par with normal operation. The isentropic efficiency of the compressors and the motor efficiencies; and the use of variable frequency solid state drives also play a role in determining the inherent efficiency of the cold storage systems.

## Solar photovoltaic power with ice storage

Solar photovoltaic power (SPV) has now become cost competitive and achieve grid parity as compared to other power sources. Mono crystalline or polycrystalline silicon SPV modules are suited for the cold storage industry because of their long life of 25+ years and their degradation is restricted to 0.8-1%/year. SPV power can be integrated to cold storage plants of 5 kilo tonnes as the primary power source without any back up power from grid or diesel plant.

Decoupling of electric power generation pattern and the cold storage operating pattern can be achieved by decoupling of time domains of cold storage chiller (or evaporator) operation and fan operation. This decoupling results in reduced electric power input (30-40 %), reduced electrical energy input (20-40%) and more effective cooling rates.

Cold storage with (cold thermal energy storage) CTES referred to as CS-CTES is a means of balancing the mismatch between the load curve and the solar generation curve. The peak power input is critical in SPV powered plants where the plant capacity directly determines the maximum power and energy generation. The focus of this paper is on integration of ice based CS-CTES with SPV power source with its peculiar variable power generation profile different from other power sources.

CS-CTES plant configuration using ice build/melt systems. Presently there are systems with chilled water as the main cooling effect carrier to Air Circulating Units (ACUs), which further convey the cooling effect through chilled air. Alternatively, there are systems where the refrigerant (NH<sub>3</sub>) from the evaporator itself carry the cooling effect till the room where it is finally dispersed by a ventilation fan (variable refrigerant flow (VRF) systems).

CS-CTES systems can be configured as follows:

- Option for cooling through either Direct chiller operation (without CTES) (chilled water scheme or VRF scheme) or ice build and melt operation.
- Cooling through Ice build and melt operation only without cooling through direct chiller operation (VRF scheme is not applicable here)
  - o External ice build and melt system
  - o Internal ice build and melt system

In an ice build and melt system, the working fluid for transferring the cooling effect is a mixture of water and antifreeze agent (viz. ethylene glycol or propylene glycol) in mass fraction of 75% / 25%. Methylene glycol has a specific heat of 3.77 kJ/kg°C (water: 3.77 kJ/kg°C) and viscosity of 3.2 mPas (water: 1.5 mPas).

In an external ice build and melt system the chilled water (plus



antifreeze liquid) is part of the melt system and is exchanged between (a) chiller and the ice storage system for ice build process and (b) the ice storage system and a heat exchanger for ice melt process. A secondary fluid is used to transfer the cooling effect from the heat exchanger into the air handling unit (AHU).

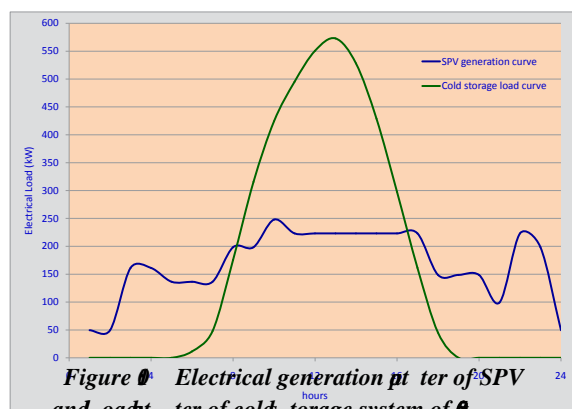
In the internal ice build system the chilled water (plus antifreeze liquid) is circulated between (a) the chiller and ice storage system during ice build process and (b) ice storage system and the AHU during the ice melt system.

Sl. No.	Particular	Units	Value
1	Capacity	tonnes	5000
2	Capacity	m <sup>3</sup>	17000
3	Specific power	kW/TR	1.18
4	Cooling capacity	TR/1000 m <sup>3</sup>	10.0
5	Electrical power	kW/1000 m <sup>3</sup>	11.80
6	Hours of operation per day	h/day	20
7	Annual hours of operation	h/year	4000
8	SEC (maximum) (design) (deemed)	kWh/m <sup>3</sup> /year	103.37
9	SEC (maximum) (operating) (deemed)	kWh/m <sup>3</sup> /year	93.03
10	Electrical power (load)	kW	200.6
11	Cooling capacity	TR	170.0
12	Daily energy requirement	kWh/day	4012.0
13	Daily energy expenditure (solar period)	kWh/day	2300.0
14	Daily energy expenditure (ice storage for non-solar period)	kWh/day	1750.0
15	Average solar load	kW	169
16	Area of crystalline silicon SPV panels	m <sup>2</sup>	4600.0
17	Capacity of SPV plant	kW	573.0

**Tab e 5 Characteristics of solar PV systems for cold storage units of 5000 tonnes.**

By creation of an off peak 'refrigeration lake' of cold liquid ammonia at low pressure through minimization of temperature stratification, the energy efficiency of the system can be enhanced by 10-12 %.

Load balance is achieved by using excessive energy for charging ice



**Figure 1 Electrical generation pattern of SPV and load pattern of cold storage system of 5000 tonnes.**

forming chillers. Ice has a latent heat of fusion of 333 kJ/kg and energy density of 92 kWh/m<sup>3</sup> as compared to 37 kWh/m<sup>3</sup> for paraffin and 63 kWh/m<sup>3</sup> for phase change salts.

Table 5 gives the characteristics of SPV system to be integrated for energizing the cold storage plant of 5 kilo tonnes.

Figure 10 gives the electrical generation pattern of SPV and load pattern of cold storage system of 5000 t. The energy storage is through creation of ice and cold liquid ammonia at low pressure under adiabatic conditions of storage.

SPV with ice storage system gives an energy saving of over 20% besides reducing the cost of battery storage to overcome the load mismatch.

## Conclusions

- The present cold storage capacity capable of meeting around 6.7% of the gross produce is 30 million tonnes (7000 units) and drawing a power of 1.2 GW or 0.5 % of the installed electrical capacity.
- A comfortable 20% cold storage coverage would require a growth rate of 12% up to 2020 to achieve a capacity of 70 million tonnes (in 2020) and subsequently 11.5% up to 2030 to achieve 200 million tonnes (in 2030). This corresponds to an electrical load in 2020 would be 2.74 GW and in 2030 would be 7.8 GW.
- The energy efficiencies (kWh/m<sup>3</sup>/year) for Indian cold storages for chilled systems (0 to 10 °C) and refrigerated systems (-18 to -25 °C) need to be brought on par with international practice. Low experimentally recorded values of energy consumption are on account of acute power cuts and not on account of improvement in energy efficiency.
- Significant areas of energy efficiency improvement are reinforcement of insulation, containment of infiltration, efficient temperature controls and retrofitting with solid state variable frequency drives for major motors.
- The energization of cold storage plants by solar photovoltaic (SPV) with ice storage is financially feasible for units of standard Indian economical capacities 5 kilo tonnes.
- For a plant of 5,000 t, a solar PV plant of 573 kW is required. The energy generated is 4054 kWh/day out of which 2,301 kWh/day are utilised directly and 1,753 would have to be used in mode of thermal ice storage and cold liquid ammonia at low pressure. ■

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# Cold Chain Conference

## Concludes In Mumbai

***The 4<sup>th</sup> International Exhibition and Conference on Cold Chain witnessed 5500+ Trade Visitors and 250+ Exhibitors; 375 representative brands; 300+ conference delegates and more than 400+ VIP buyers...***





The 4<sup>th</sup> International Exhibition and Conference on Cold Chain held from 16 to 18<sup>th</sup> December 2015, at Bombay Exhibition Centre, Mumbai. It was a three-day-event of informative and valuable networking, where the entire Cold Chain Industry was presented under one venue.

The event was welcomed and applauded magnanimously by all attendees and recognized as 'THE EVENT' of the Cold Chain Industry. The organisers are very thankful to the Govt. Institute (NCCD and NIFTEM), Industry Associations (FCAI, AAR, AFTPAI and AIFPA) for their help that made India Cold Chain 2015 a grand success.

The show witnessed 5500+ Trade Visitors and 250+ Exhibitors; 375 representative brands; 300+ conference delegates and more than 400+ VIP buyers with grand support from Media Partners. The extensive international presence, strong business visitors and continued support of

The Exhibitors expressed their complete satisfaction at being able to meet the top cold chain industry representatives from India and abroad. They also spoke approvingly of the exhibition as they were able to get the first-hand, factual information and great business leads.

The two days of extensively planned and focused conference designed by the experienced industry veterans on "Trends and innovative solutions in cold stores modernisation; and soft skills development etc., sea food industry towards making it vibrant. We are delighted to have dignitaries Dr. Ajit Kumar, Vice Chancellor, NIFTEM; Bijay Kumar, Principal Secretary, Govt. of Maharashtra and Wouter Verhey, Agriculture Counsellor Netherland Embassy, Mahinder Swarup President Cold Storage Federation of INDIA for sharing the insight required for the growth of the industry," commented the organisers.

"The exhibition exceeded expectations this year too and it's always



industry leaders – such as VE Commercial (Eicher Trucks), Pluss Advance PCM Technology, DORIN Innovation and Holland Pavilion resulted in ICCS acting as a major influence in the shaping of the entire Cold Supply Chain industry in India and set new standards.

Visitors from all over the country visited the exhibition and obtained information on the Cold Logistics, Reefer Trucks, Temperature Control, Cold Storages, Refrigeration and Storage & Distributions, the show served as the India's Largest dedicated platform for the Cold Chain industry.

our highest priority to cater with quality service and support, so that our partners can gain the best networking and interactions with the visitors in the exhibition. The exhibition now is the largest gathering of Cold Chain Solution providers in India. We are hopeful that all the attendees have been benefited during the three days of serious business networking. Also, very happy to announce the 6<sup>th</sup> edition of India Cold Chain Show 2016, 17 to 19<sup>th</sup> October to be held in Bombay Exhibition Centre Hall no. 5, Mumbai," said Anuj Mathur, Managing Director, Reed Manch Exhibitions Pvt. Ltd. ■



# Managing Indoor Air Pollution



*In India, the IAQ awareness is not as high as is in the developed world nevertheless it is not very less as agencies like ISHRAE, ASHRAE, certain NGOs have been at the forefront for this mission...*

Indoor Air Quality (IAQ) or Indoor Air Pollution refers to the Air Quality within and around buildings and premises used for residential, commercial or factory premises and its surroundings – especially as it relates to the health and comfort of its occupants. IAQ can be affected by gases (including carbon monoxide, carbon dioxide, radon, volatile organic compounds that include but are not limited from sources such as smoke, toxic gases, kerosene fumes, unvented and malfunctioning furnaces & stoves, building materials such as paint, furnishings, pollen, varnish etc. personal care products), particulates, microbial contaminants (mold formed due to humidity, bacteria), or any mass or energy stressor that can induce adverse health conditions.

Ventilation, filtration and control of source are the primary ways to dilute contaminants for improvement of Indoor Air Quality in most occupied premises. Residential units can further improve indoor air quality by routine cleaning of carpets and area rugs. Cleaning based on traffic, number of household members, pets, children and smokers usually help create a framework guidance for IAQ improvement. Carpets and rugs act like an air filter and must be cleaned.

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

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

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

A way of quantitatively ensuring the IAQ is by the frequency of effective turnover of inside air by replacing it with outside air. In the UK, for example, classrooms are required to have 2.5 outdoor air changes per hour. In gymnasiums, physiotherapy spaces and restaurants & dining areas, the ventilation should be sufficient to limit carbon dioxide to 1,500 ppm. In the US, and according to ASHRAE Standards, ventilation in classrooms is based on the amount of outdoor air per occupant plus the amount of outdoor air per unit of floor area, not air changes per hour. Since carbon dioxide indoors comes from occupants and outdoor air, the adequacy of ventilation per occupant is indicated by the concentration indoors minus the concentration outdoors. The value of 615 ppm above the outdoor concentration indicates approximately 15 cubic feet per minute of outdoor air per adult occupant doing sedentary office work where outdoor air contains 385 ppm, the current global average atmospheric CO concentration.

In classrooms, the requirements in the ASHRAE standard 62.1, Ventilation for Acceptable IAQ, would typically result in about 3 air changes per hour, depending on the occupant density. Here as we now know the occupants aren't the only source of pollutants, so outdoor air ventilation may need to be higher when unusual or strong sources of pollution exist indoors. When outdoor air is polluted, then bringing in more outdoor air can actually worsen the overall quality of the indoor air and exacerbate some occupant symptoms related to outdoor air pollution. Generally, outdoor country air is better than indoor city air. Exhaust gas leakages can occur from furnace metal exhaust pipes that lead to the chimney when there are leaks in the pipe and the pipe gas flow area diameter has been reduced.

Moisture management and humidity control requires operating HVAC systems as designed. Moisture management and humidity control

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

The 'dew point temperature' is an absolute measure of the moisture in air. Some facilities are being designed with the design dew points in the lower 10s °C, and some in the upper and lower 4, 5 °C. Some facilities are being designed using desiccant wheels with gas fired heater to dry out the wheel enough to get the required dew points. On those systems, after the moisture is removed from the make up air, a cooling coil is used to lower the temperature to the desired level.

Figure 4. (next page) Shows a Telaire make Dewpoint Sensor used for moisture removal/prevention of mold formation...

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

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

## Institutional Program

A variety of scientists work in the field of indoor air quality including chemists, physicists, mechanical engineers, biologists, bacteriologists and computer scientists. Some of these professionals are certified by organisations such as the American Industrial Hygiene Association, the American Indoor Air Quality Council, the Indoor Environmental Air

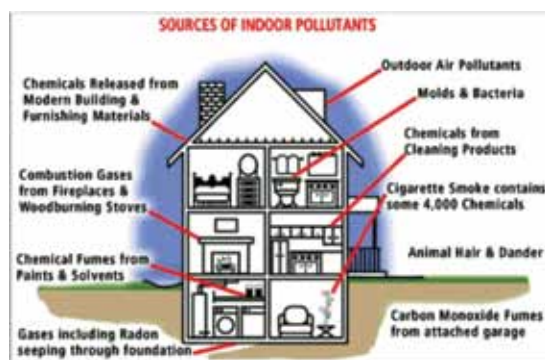


Fig. 1 (above) Shows sources of Indoor Air Pollution. (Picture courtesy environmentmasters.com)



Figure 2. (above) A common air filter, being cleaned with a vacuum cleaner...



Figure 3 (above) shows an Aerosense make Indoor Air Quality Sensor...



Figure 4 (above) Shows a Telaire make Dewpoint Sensor used for moisture removal/prevention of mold formation...

Quality Council and Indoor Air Quality Association (IAQA).

While this article is being written there is a news of approval of consolidation between ASHRAE and IAQA. The consolidation was seen by both Boards as beneficial to ASHRAE and IAQA in that it strengthens the programs and services of both organizations. The work of IAQA complements the work of ASHRAE in its standards, research, publications and educational offerings.

The two associations now combine their resources to ensure the industry receives the best indoor air quality technical guidance and educational programs possible, which means improved indoor air quality.

Regularly, on the international level, the International Society of Indoor Air Quality and Climate (ISIAQ), formed in 1991, organises two major conferences, the Indoor Air and the Healthy Buildings series.

ISIAQ's journal *Indoor Air* is published 6 times a year and contains peer-reviewed scientific papers with an emphasis on interdisciplinary studies including exposure measurements, modelling and health outcomes.

In India, the IAQ awareness is not as high as is in the developed world, nevertheless it is not very less as agencies like ISHRAE, ASHRAE, certain NGOs have been at the forefront for this mission.

We are also aware that IAQ is also related to cleanliness and therefore with the advent of our Prime Minister's Clean India Campaign (Swachh Bharat Abhiyan), I am sure the awareness for cleanliness and in turn IAQ will be higher and widespread.

(Source: ALM)

## 5 Tips For Space Heater Safety

As temperatures drop in winter, many people look for supplemental heating sources for their homes. Space heaters can be a good solution for them. Also in industries, these heaters find varieties of applications. Unfortunately, according to the National Fire Protection Association (US), space heaters are responsible for 32% of house fires. Tipmont REMC is offering five tips to enhance safety of the space heater users.

**Materials:** What are the components of your space heater made of? Parts like metal grating can be hot to the touch and may burn anyone who gets too close. Make sure you purchase a heater that is cool to the touch and has guards over the coils just in case little fingers get too close.

**Placement:** While it can be tempting to place a small heater on a shelf so it is not in the way of pets and children, it is safest to leave the heater on a level floor on a nonflammable surface. Keeping the space heater on the floor can keep it from falling over, preventing fire hazards. Also, remember that space heaters and bathrooms are not a good combination, unless the heater is designed for bathroom use. Moisture can damage the heater.

The most important rule about space heater placement is the three-foot rule. Whether you are using the heater in the bedroom, living room or kitchen, space heaters should always be kept three feet

away from flammable materials and out of the way of children and pets.

**Special features:** Does your space heater have an auto shutoff function if tipped over? Auto shutoff can be a lifesaver. If you currently own a space heater without auto shutoff, consider purchasing a heater with this important safety feature.

**Cords:** You should never use an extension cord when plugging in a space heater as it can cause overheating. The space heater should be plugged directly into a wall outlet, and should be the only thing plugged in to the wall outlet. Also make sure cords aren't in a high-traffic area so they are not a tripping hazard.

**Use:** Never leave a heater unattended while in use. If you are leaving your home or going to bed, make sure to unplug the heater.

Following these tips and making sure to follow the manufacturer's instructions can keep you safe. All these tips are equally applicable to industries.



(Courtesy: www.tipmontorg)



## Measure Just With Your Smartphone

**T**esto extends their range of digital measurement solutions with the new Testo Smart Probes. These innovative, pocket-sized pro measuring instruments can be intuitively operated by smartphone via a free App, and transported in a space-saving case. They are suitable for all important temperature, humidity, pressure and flow velocity measurements.

The smartphone makes our day-to-day life easier in almost every aspect. Taking this thought as the idea, Testo decided to integrate the feature of smart working into measurement tasks as well – and the result is eight compact measuring instruments, which can be connected to the smartphone or tablet via Bluetooth, and conveniently and intuitively operated via App. Despite their small format, the Smart Probes are equipped with the market leader's customary pro measurement technology, and are suitable for all important temperature, humidity, pressure and flow velocity measurements.

### Operate all measuring instruments with one App

The central operating element of the Bluetooth measuring instruments is the versatile Testo Smart Probes App. It can be installed for free as an iOS or Android version, and offers the user many practical functions, including clear measurement value readout, curve display of the measurement data in graph or tabular form, as well as the dispatch of the measurement data as a PDF report or Excel file. More application-specific

measurement menus make working with the Smart Probes even more efficient. These include menus for pressure-drop testing in heating applications, for easy parameterisation of the outlet/duct cross-section in the context of volume flow measurement, or for the calculation of different parameters – such as superheating or sub-cooling in refrigeration systems. The App is easy and intuitive to use, and can simultaneously show the values from up to six Smart Probes in the display.

### Refrigeration, air conditioning and heating sets at special prices

In order to facilitate refrigeration, air conditioning and heating contractors with all the measuring instruments necessary for their daily jobs with them at all times, Testo offers tailor-made sets for each target group at a special price.

Each set also includes the testo Smart Case, which is a robust and flexible hard shell on the outside with a soft foam rubber inlay inside with fitted compartments for the individual measuring instruments. It allows the



**Testo decided to integrate the feature of smart working into measurement tasks as well...**

Smart Probes to be safely stored and comfortably transported.

The new Smart Probes from Testo are the ideal entry-level instruments for contractors with an enthusiasm for technology and also for measurement professionals who do not wish to carry all their equipment with them at all times.

**For further information:** [www.testo.in/smart-probes](http://www.testo.in/smart-probes) ■

## MECO presents Air Flow Anemometer (Model: 961P)

**M**ECO Air Flow Anemometer (Model: 961P) is used to measure wind speed and temperature. It acts as an indicator that spins in the wind. It gives a direct measure of the speed of the wind. It is mainly used in HVAC industry for measuring air flow of air conditioners.

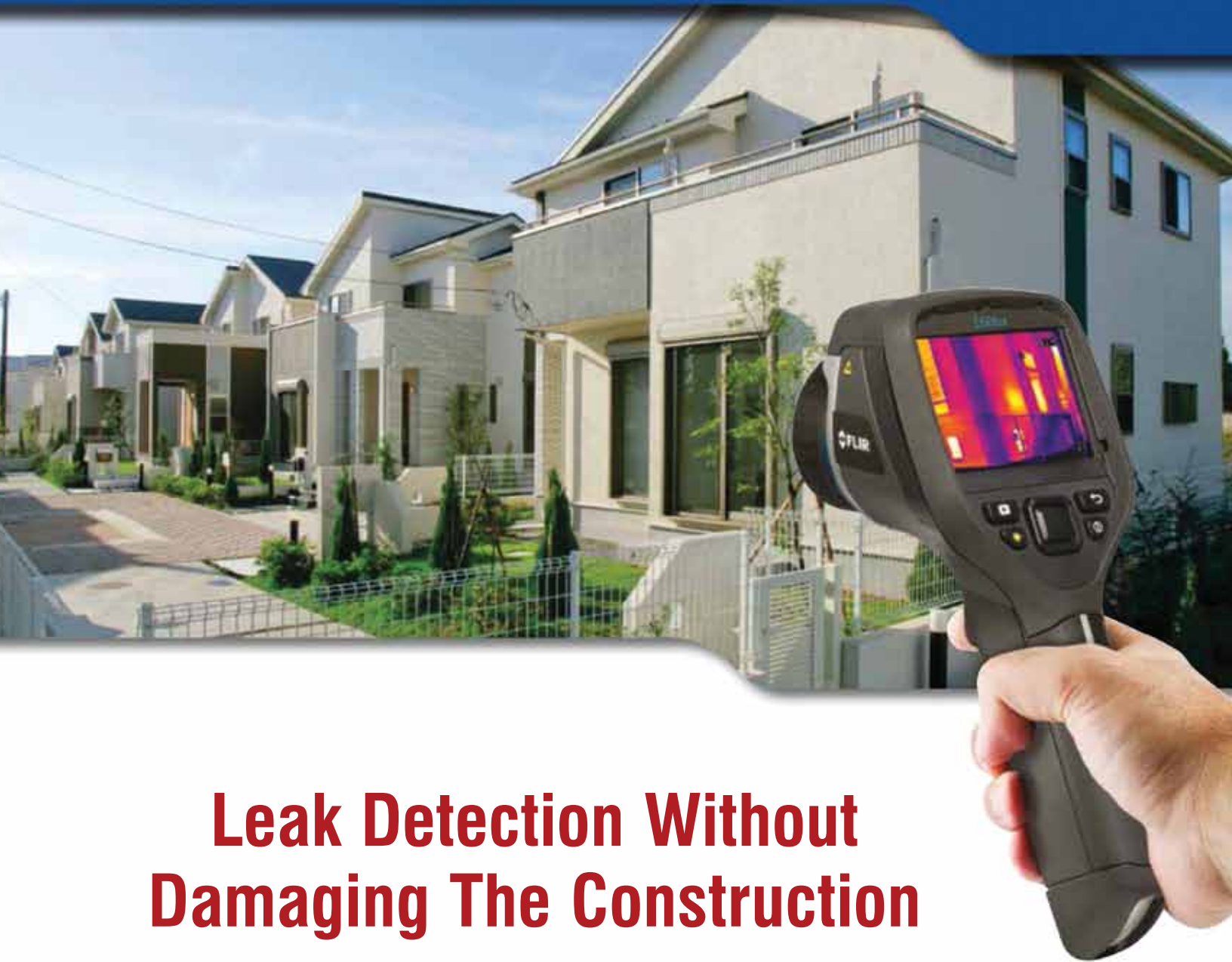
Measuring range for air flow is 1 ~ 25m/s and for Temperature 0 ~ 50°C

The meter is equipped with some special functions such as m /Sec, Ft / min, Knots, Km / h, MPH, CFM, MAX / MIN / HOLD, and Auto Power Off.

It is widely used because of its portability, light weight, accuracy. It has long battery life. It is user friendly.

**For further information:** [www.mecoinst.com](http://www.mecoinst.com) ■





## Leak Detection Without Damaging The Construction

***Purchasing a house is a major financial investment for anyone. Since a house is fundamental to security of life, it is immensely important to invest in the right property.***

***As the leading expert of home inspection in Japan, first-class architect Mr. Hiroshi Ichimura, uses FLIR's infrared thermography for building diagnosis. Ichimura has established his 'Home and Estate Consulting Center' to provide inspection and diagnostic services in line with customers' requirements. Some customers want houses built from plans so involvement will be from contract to finished construction – whereas others want diagnostics on completed new-build...***

**F**LR System's infrared thermography can detect building problems, which are invisible to the naked eye. Thermal imaging cameras can visualise building problems such as missing insulation, air leaks, condensation, mold and leaks in floor heating so as to indicate the exact location of the problem.

Based on his experience as a first-class architect who has engaged in the design of about 1800 buildings over 20 years, Mr. Ichimura has so far diagnosed over 200 buildings through his service as a home inspector; a role which was almost unheard of in Japan prior to 2001 when his company was officially accredited as a third party inspection body.

Customers can be divided into two types; those who plan to build a new house and require inspections from contract to completion and those who have already moved into a house (such as a built-for-sale house) and require a house inspection to disclose potential defects.

"Infrared thermography is very useful for inspections during construction and also post construction diagnosis of built-for-sale houses, where it is especially useful in detecting missing insulation and water leaks," Mr. Ichimura commented.

He continued "Although insulation strategies may vary depending on construction methods, the appropriate and careful selection and placement of insulation can have a huge impact on heat-insulation efficiency. Using infrared thermography enables you to ensure visually that the choice and installation of insulation is correct. During construction stages, you can check the presence of space between insulation materials and if required request remedial work, to prevent new homes being defectively built."

"For water leaks, severe leaks can be visible as a stain on the building materials but normal moisture ingress is very difficult to identify and locate. Conventionally, moisture inspection was laborious and time-consuming. First, a house inspector would guess where a leak might occur based on the structure of the house. Then, a water leak would be simulated and the site of the suspected leak tested by touching it. The biggest problem with using the conventional method was that in order to judge the extent of the leak further damage had to be caused to the building. Using infrared thermography, however, it is possible to determine the exact location and degree of the leak without causing damage and allowing efficient inspections," explained Mr. Ichimura.

He uses the FLIR b60 thermal imaging

camera for these applications. The FLIR b60 for building diagnosis is a handheld infrared camera. It produces crisp thermal images of 180 x 180 pixels and has a 2.3 Megapixel digital camera on board. It also includes the extra features you need for building diagnosis such as dewpoint and insulation alarms that highlight areas with risk of surface condensation where mold growth could occur.

"Infrared thermography enables the visualisation of problem areas seen on thermal images. With reference digital photos, which show the problem location, it allows us to provide instructions to improve construction operations and to carry out remedial work after the completion of the building. With the infrared images clearly evidencing the problem, the construction agency is forced to admit a defect in the construction," he said.

Mr. Ichimura also said that there are several points to take into consideration when performing building diagnosis with infrared thermography, "Infrared thermography has become more affordable than before and useful as a building diagnostic tool for visualising problem areas. It should be noted that it is essential to understand the structure of each building and simulate the situation where the problem is likely to occur in order to test accurately and increase inspection efficiency. ■

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## An award winning project by Aedas in China



*The porous nature of the stones is reflected architecturally by voids and spaces inside the building to facilitate interaction and allow a series of sustainable design features... (Image: www.aedas.com)*

**X**i'an Jiaotong-Liverpool University Administration Information Building, designed by Global Board Director Andy Wen, is the main administrative building of the university and gives a modern interpretation of the famous Taihu stones, which are always found in Suzhou gardens.

The porous nature of the stones is reflected architecturally by voids and spaces inside the building to facilitate interaction and allow a series of sustainable design features. The building won a prestigious Gold award HKIA Cross-Strait Architectural Design Awards 2015.

"The Cross-Strait region has been developing rapidly and presenting tremendous opportunities for architects over the past 10 years. Aedas is proud to grow with the region and will continue to tailor world-class, timeless architecture for the communities," said Keith Griffiths, Chairman of Aedas. ■

## The Statoil building that won several awards

**S**tatoil regional and international offices received WAF 2013 award for best office building. The building consists of five main elements that have different orientations relative to the surrounding landscape and the Oslofjord. The design is rooted in the democratic principle of bestowing all users of the building with excellent working conditions that include stunning views and good light conditions.

This was a comprehensive and integrated project that merges modular construction and cost effectiveness in a modern Scandinavian way, demonstrating a deep understanding of democratic and social values in the new working environment. The whole social life of the building revolves around a central circulation tower fostering high levels of casual interaction in a company that shares international knowledge. An almost column free open and light interior makes a delightfully stimulating workplace. ■



*The project had also received the WAF 2009 award, for best future commercial project. At that time the jury recognized a-lab as "a young architecture office with balls"... (Image: Ivan Brodey, Courtesy: <http://a-lab.no>)*

## Karuna House: an exemplar of high design in high performance home building



*To achieve the three certifications and meet its net positive energy goals, the Karuna House combines an advanced building enclosure with optimized solar design... (Source: Hammer & Hand)*

**K**aruna House earned 2014 Green Home of the Year Awards from Green Builder magazine, making Hammer & Hand the sole recipient of multiple awards from the US national competition. The house designed by Holst Architecture, won the 'Best Building Science' award in recognition of its advanced, high performance building envelope. The house is an exemplar of high design in high performance home building. Perched on a hilltop overlooking the vineyards of Yamhill County, Oregon, the home is the first green building in the world to earn Passive House (PHIUS+), Minergie-P-ECO, and LEED for Homes Platinum certifications.

To achieve the three certifications and meet its net positive energy goals, the Karuna House combines an advanced building enclosure with optimized solar design to drive energy loads to very low levels. Remaining energy needs, including the charging of the client's electric car, are readily provided by a solar photovoltaic array of less than 10 kilowatts. The project's laser focus on energy performance is complemented by the broad sustainability and human health goals required by LEED and Minergie-ECO. ■



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