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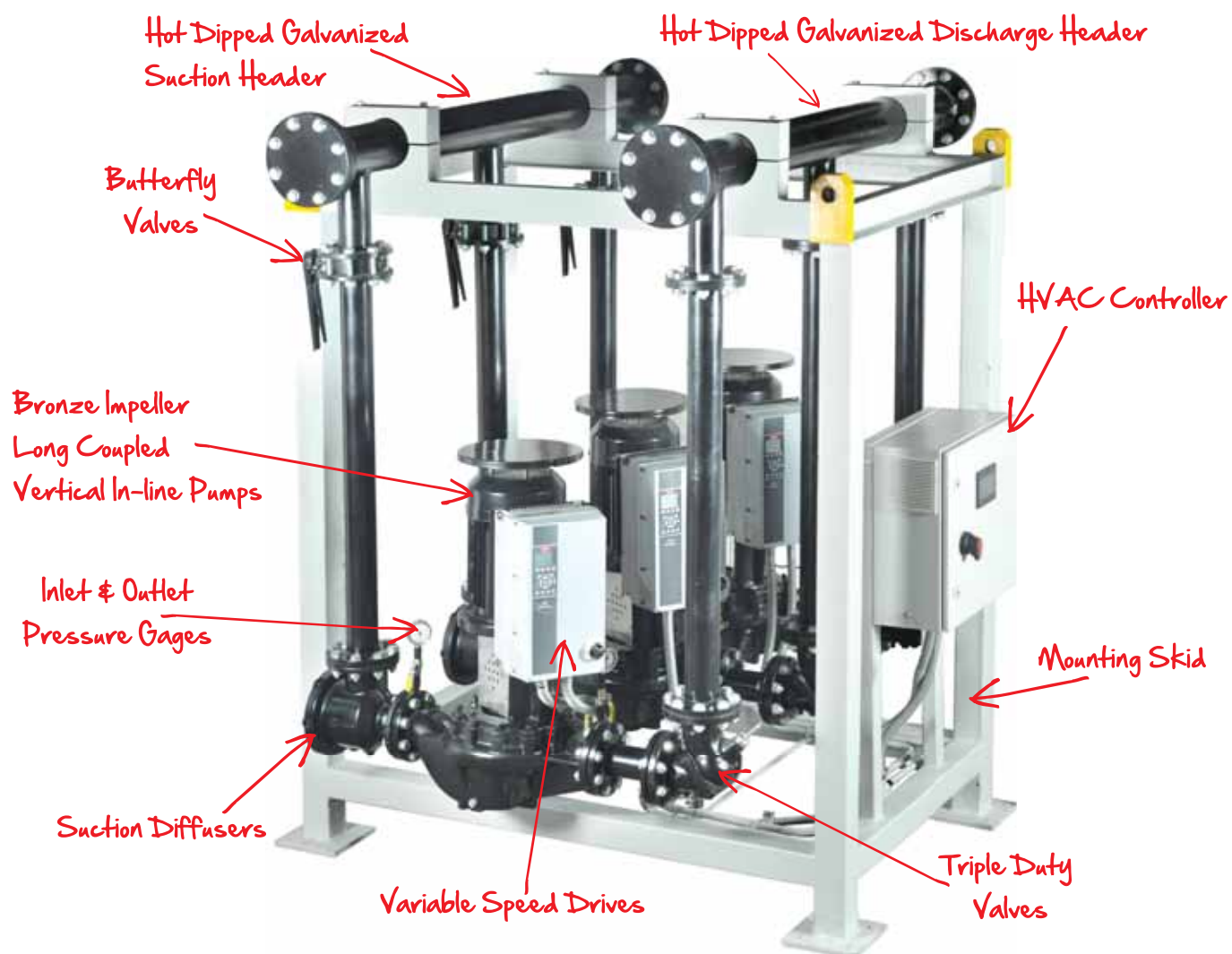


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MA24-00



Publisher's Letter

Good monsoon can push economy to near 8%

Hello and welcome once again to Cooling India. We are in the midst of peak of summer with mercury touching 45 in some parts of the country. I hope monsoon hits the southern coast early next week and we get sufficient rainfall throughout the country. A good rainfall would definitely rein in food inflation. Also a well-dispersed rainfall would certainly increase the farm income, which in turn will lead to increased demand for consumer durables.

The Indian economy is in the upward trend. We are doing much better than most of the economies, including China. At around 7%, and expected to touch 7.5% in 2017-18, the Indian economy is resilient with low inflation, fiscal prudence and low deficit. In fact, some experts see the economy grow to about 7.9% if the monsoon is normal and the global situation does not deteriorate. Better agricultural growth will provide the much-needed impetus to the overall economic growth.

Increased food production coupled with proper cold storage facilities that has been initiated by the government will help boost the farm export sector. As I mentioned in my previous note, the government has taken up on a top priority steps to increase the cold chain projects in the country. Once completed, with a storage capacity of about 2.76 lakh tonne of cold storage, the large agricultural produce generated because of good monsoon will yield positive result in terms of generation of foreign reserves.

As we discuss about good monsoon and cold storage, it is also important that our cold storage facilities adhere to proper safety measures and standards. In this issue we have an informative article on the safety measures and precautions that need to be taken into account while constructing and post construction of cold storage facilities. We also have an interesting article on how to conserve energy in clean rooms, which is so important in today's modern industrial environment. When we talk about environment, the quality of air we breathe can not be compromised. How to keep the indoor air clean and free of dust particles is dealt with in detail in an article on "The Environment in our Rooms". Hope you enjoy reading the issue as much as we have in putting it together for you. Wish you happy reading and good monsoon. Cheers.

Do send in your comments to me at pravita@charypublications.in

Pravita Iyer

Publisher & Director

Member, Indoor Air Quality Association (IAQA)



Directors

Mahadevan Iyer
Pravita Iyer

Publisher

Pravita Iyer

Editor-in-Chief

Mahadevan Iyer

Editorial Coordinator

Nafisa Kaisar
nafisa@charypublications.in

Advertising Manager

adv@coolingindia.in

Design

Nilesh Nimkar
charydesign@charypublications.in

Subscription Department

sub@charypublications.in

Accounts

Dattakumar Barge
accounts@charypublications.in

Customer Care

Sonali Pugaonkar
mktg@charypublications.in

Cooling India is also available online on
www.coolingindia.in.
For online enquiries contact:
dgmktg@charypublications.in

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2	Chilled Water Temp in °C (Assumed)	5°C	5°C
3	Supply Temp. from CT / LTMCS	33°C	30°C
4	Approach to WBT	4°C	1°C
5	ΔT for Chiller	28°C	25°C
6	Chilled Water Compressor Motor Kw for 1200 TR	720	643
7	Energy Saved in %	-	10.7%
8	Energy Saved in Kw	-	77 Kw/Hr
9	Total Running Hours per Annum	8640	8640
10	TOTAL POWER SAVED PER ANNUM	-	6,65,280 Kw



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E-mail : mistcreation@gmail.com ■ mistcool@vsnl.com ■ Website : www.mistcreation.com



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"There is a lot of potential for the cold storage industry in our country"

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Ravichandran Purushothaman
President, Danfoss Industries Pvt Ltd



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Honeywell Expands Production of Gas Solutions at Russian Plant

Honeywell Process Solutions (HPS) announced that it will expand the manufacture of oil and natural gas solutions for the Russian sector at its Arzamas plant. This will include gas measurement equipment and gas regulators for medium and high-pressure applications.

The expansion will include new production lines, equipment and training at the company's existing plant in the Nizhny Novgorod region of Russia. The plant is part of Honeywell's Elster Gazelektronika business.

"These oil and gas solutions are very important to the growing sector in Russia," said Alexei Zenkevich, HPS business leader for Russia, Belarus and Armenia. Elster Gazelektronika will add production lines at the Arzamas plant. The first is Elster gas measurement equipment, including the Q.Sonic Ultrasonic flow meter range for measurement of gas flow and volume, the EnCal 3000 gas chromatograph for gas composition analysis, FC1 flow computers, and metering skid solutions.

Elster's gas measurement solutions are widely used in natural gas fields, at metering stations and in the transportation of gas by major oil and gas companies in Russia.

A second new line will produce Honeywell natural gas regulators for medium and high-pressure applications. Many Russian natural gas companies use this equipment to control the pressure of gas production and transportation systems.

Honeywell acquired Elster, a German-based provider of gas heating, controls, metering and advanced technologies, in 2015. The company's Russian subsidiaries include Elster Metronika, a market leader in metering systems, and Elster Gazelektronika, a provider of gas measurement and control products. ■

Chile Makes Air Quality Commitment with New Energy Strategy

The Government of Chile has announced a new district energy strategy to improve air quality. Air pollution is responsible for 4,000 annual cases of fatal cardiovascular disease nationwide. This costs the economy US\$8 billion a year in medical expenses and lost. The Government of Chile announced the adoption of a new district energy strategy to improve air quality for its citizens at the Third Sustainable Energy for All Forum.

"Our cities are struggling to tackle air pollution from burning firewood for heating. This is causing an urgent health crisis for our citizens," said the country's Environment Minister Marcelo Mena. "In collaboration with UN Environment and its partners, we have initiated Chile's first district energy strategy. This strategy will set in motion the policies and investments required to demonstrate and scale up this solution in our cities and regions. We are considering

up to US\$60 million in soft loans and financial instruments to support this vital solution as part of our sustainable heating strategy."

Temuco, a city of 290,000 inhabitants in Chile's south, is one of the cities that has signed up to receive support from UN



Environment's District Energy in Cities Initiative, a public-private partnership. Temuco's air quality is the third-worst in Chile, with dangerous pollutant concentrations five times higher than World Health Organization standards. Some 94 per cent of this air pollution is attributed to wood burning for heating single-family homes. ■

Emerson & Goodman to Offer Copeland Scroll Compressors

Emerson has announced that its next generation Copeland Scroll™ two-stage compressor will be offered in Goodman Manufacturing's new 16-18 SEER systems. The new Goodman 16-18 SEER systems featuring the Copeland Scroll two-stage compressor provide contractors with an ideal way to help homeowners get the comfort and efficiency they want at an accessible price. Two-stage systems run at full capacity or 65 percent, which helps keep humidity at bay while reducing energy use.

The Copeland Scroll two-stage compressors modulate mechanically by bypassing a portion of the gas in the scroll back to suction. "Goodman is very excited to be the first to introduce the next generation Copeland Scroll two-stage compressor in our 16 and 18 SEER product line up. We think

dealers and homeowners will like the enhanced comfort these two-stage systems deliver over fixed capacity systems at a refreshingly affordable price too," said Lawrence M. Blackburn, EVP and President, Goodman Business Unit.

"As SEER ratings continue to push our industry to higher efficiency standards, homeowner expectations toward comfort are also rising. We are happy to be joining with Goodman to bring this affordable and efficient offering to the market. Goodman's selection of our new Copeland Scroll two-stage compressors is a great testimony to the reliability, efficiency and affordability of this modulation technology," said Brandy Powell, Vice President And General Manager, residential air conditioning for Emerson's Commercial and Residential Solutions platform. ■



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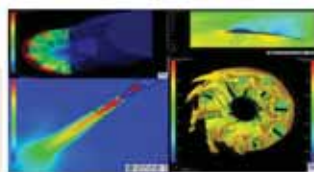


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Emerson Teams with VJTI to Tackle Industrial Challenges

With an eye on promoting fresh thinking to help solve complex industrial problems, Emerson Process Management announced that it has teamed with Veermata Jijabai Technological Institute (VJTI) to launch a co-innovation initiative focused on industrial and technology issues. The new Emerson Center for Advanced Studies located on the VJTI campus in Mumbai will enable faculty and students to work on solving real-life industrial problems such as energy consumption, industrial safety, plant efficiency and reliability.

Using state-of-the-art equipment and technology, students will be able to work on challenges put forth by both their professors and those brought to them by Emerson and other companies. The Center is designed to promote a framework for a blend of theoretical and practical solutions. Problems that act as hindrances to efficiency and reliability can now find potential answers at the new Emerson Center for Advanced Studies. For instance, electric production and power grid reliability are ongoing challenges in India. In July 2012, 670 million people were left without electrical power when three out of five of India's regional power grids collapsed in the largest blackout month in history. This is the kind of high-stakes challenge the new Emerson Center will study and develop innovative solutions to help solve. The collaboration aligns with Emerson's support towards Skill India.

"We have a strong tradition of collaborating with leading universities in the countries where we operate. The Emerson Center for Advanced Studies at VJTI will help students identify common industrial and technology challenges and develop solutions," said Dr Amit Paithankar, Managing Director of Emerson Process Management India. ■



Aspen Launches First On-Demand Condensate Pump

Aspen Pumps has launched the first on-demand condensate pump - the Micro-v i4. The next generation of condensate pump, the Micro-v i4 only operates as needed and as a result boasts cost and energy saving benefits, as well as quiet running and a longer life with a two year warranty. The Micro-v i4 mini pump does not use a breather tube so it saves even more space when trying to install into the tightest of locations. Featuring a worry and maintenance free plug-and-play installation, the Micro-v i4 can be installed in multiple orientations and operates on-demand so is never continually running.

Ideal for projects where energy efficiency is a must or where high energy loads from existing plant are an issue, on-demand operation makes common sense, saving energy for the end-user and reducing carbon emissions. Designed with intelligent sophisticated controls and clever sensors that collect data, the Micro-v i4 adjusts switching levels and

motor speed depending on the flow rate, thus ensuring, it is only working and removing condensate when it is needed.

Suitable for high wall split systems, ducted units and floor standing and



chassis AC units, the mini pump is ideal for installing directly inside the Air Conditioning unit. The Micro-v i4 does not use a breather tube and only one connector is needed when installing it in high wall units, further adding to its installation versatility.

With sound levels a key comfort and health and wellbeing issue for end-users, the Micro-v i4 is almost silent at only 19dBA, which is below the sound of leaves rustling! This makes the pump ideal for high-spec applications where silence is key, such as hotel rooms or art galleries. ■

GBCI Continues its Expansion in Europe

Green Business Certification Inc (GBCI), the premier organization independently recognizing excellence in green business industry performance and practice globally, announced the opening of a new European office in Munich recently. Through certification and credentialing standards, GBCI drives adoption of green building and business practices. Kay Killmann has been named Managing Director of GBCI Europe.

"Europe has been a leader of the green building market for a long time and we are continuing to see tremendous interest and support for LEED in the region," said Mahesh Ramanujam, President and CEO, GBCI. GBCI's expansion into Europe will help facilitate the growth and advocacy of LEED, the world's most

widely used green building rating system, and GBCI's other sustainability programs in the European region. The new office will also provide local, on-the-ground support to clients in the region and improve access to GBCI's sustainability programs and resources.

Since 2008 GBCI has exclusively delivered more than 37,700 LEED certifications to green building and community projects around the world and has established a world-class infrastructure. Currently, there are more than

5,200 LEED registered and certified projects in Europe. Killmann and his team will be responsible for the market development efforts of GBCI Europe and will ensure the advancement of LEED and other GBCI sustainability programs in the region. ■



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Maximizing Safety & Efficiency at Turkey's Airport

Honeywell, a global software-industrial technology company and leader in aviation and airport solutions, has signed an agreement with IGA Airports Construction to provide its Advanced Visual Docking Guidance System (A-VDGS) for IGA's Istanbul New Airport currently under construction in Istanbul, Turkey. The technology will help speed airplane gate arrivals and departures safely and efficiently, and optimize gate capacity at the new airport, which is anticipated to be one of the world's largest airports upon its completion in 2018.



With an annual capacity of 200 million passengers, the Istanbul New Airport is expected to serve more than 350 destinations and operate as one of the biggest aviation hubs bridging the East and the West. The project, which is divided into four construction stages, includes the development of four independent runways and a main terminal with 114 visual docking guidance systems, all of which are to be provided by Honeywell under the terms of the agreement. "With Istanbul New Airport set to become one of the largest and busiest airports in the world, a state-of-the-art docking guidance system is critical for safe, efficient and precise aircraft movements to and from the gate," said Yusuf Akçayoğlu CEO of IGA Airports Construction. "We have selected Honeywell's Advanced Visual Docking Guidance System solution because of its ability to best meet our operational requirements and capability to communicate with other airport systems for improved performance and efficiency." ■

Bitzer Expanding Market Presence in West Africa

Bitzer is convinced of the economic potential of West Africa and is opening an office in Nigeria. The new office reports to Bitzer Kuehlmaschinenbau (SA) (Pty) Ltd in South Africa and will get organisational support from there. Bitzer is convinced of the growth opportunities in West Africa and, for the first time, will be represented directly in Lagos with its own office from the beginning of 2017.

With the office in Lagos, Bitzer has established a presence closer to users in West Africa and would like to better support business partners and users in the region. "With its significant population and favourable location, Nigeria represents the ideal starting point from which to



strengthen BITZER's presence in the West African market," says Bernhard Blaeser, Managing Director, Bitzer South Africa. "We at Bitzer are convinced that Nigeria will undoubtedly be one of the most important markets in Africa, which is why we would like to increase our activities there."

The middle class in Africa's most populous country is constantly growing and the economic output is the largest on the continent, resulting in an increase in demand for refrigeration and air conditioning technology. Because modern supermarkets have been popping up at full speed all over Nigeria for around five years now, there's currently a high demand for reliable, efficient compressors for food refrigeration. ■

Carrier Transicold Brings Engineless Refrigeration to UK

Carrier Transicold's ICELAND engineless multi-temperature undermount refrigeration unit is making its UK exhibition debut at the CV Show. This new generation of transport refrigeration technology aims to improve sustainability for fleets. Carrier Transicold, which operates in the UK as Carrier Transicold (UK) Limited, is a part of UTC Climate, Controls & Security, a unit of United Technologies Corp. The electric system offers a cooling capacity of up to 18,400 watts and operates with Carrier Transicold's ECO-DRIVE GenSet to harvest power from the truck's clean Euro VI engine. This helps fleets reduce their environmental impact by cutting emissions and improving fuel efficiency, whilst also reducing maintenance costs.

Configured with dual compressors and economisers, the ICELAND unit operates on different refrigerating circuits, which helps maintain maximum capacity, even at idle. For multi-temperature applications, this means there is no power drain created by having to separate the power of a single compressor across two compartments, making it efficient for operators and enabling the system to provide cooling and

heating at the same time.

"With this addition to our range we can offer the equivalent power capacity of a high output trailer unit," said Scott Dargan, Managing Director, Carrier Transicold, Northern Europe and Service EMEA. "Mounted beneath a rigid truck or drawbar



chassis, the system features very few moving parts and is extremely quiet, operating below 60dB. It's the ideal transport refrigeration system for urban distribution truck fleets requiring a high cooling capacity from low engine speed and with limited impact on the environment."

On the stand, the ICELAND unit and the ECO-DRIVE systems are mounted to a Mercedes-Benz Antos distribution vehicle supplied from Carrier Transicold's European demonstrator fleet. ■

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Johnson Controls' Compressor Lab in Waynesboro

Johnson Controls has completed construction and launched operation of a new \$6.7 million screw compressor testing laboratory at its Waynesboro, Pennsylvania manufacturing plant. At 7,000-square-feet, the facility is one of the largest, most sophisticated testing laboratories in the screw compressor industry.

The new laboratory is used to test large screw compressors that support refrigeration and gas compression applications in the oil and gas and process industries. It allows Johnson Controls to load test and confirm performance of its compressors so customers can purchase the technology with complete confidence.

"We take our role in US-based manufacturing very seriously, and this lab really drives that point home," added Bill Jackson, President, Johnson Controls Global Products. "With its impressive size and capabilities, we're confident that this lab will soon be known as the center for screw compressor technology in North America. With its impressive size and capabilities, we're confident that this lab will soon be known as the center for screw compressor technology in North America." -- Bill Jackson, President, Johnson Controls Global Products.

Johnson Controls uses the laboratory to test industry-leading screw compressor technology, starting with the company's new "RWHII" Series 408-mm sleeve bearing screw compressor and "HPSH" Series high-pressure line. The 408-mm sleeve bearing screw compressors are primarily used in large American Petroleum Institute (API) oriented applications in the oil, natural gas, and petrochemical industries. Applications for the HPSH line include gas turbine fuel gas boosting, CO₂, and heat pump systems.

At the heart of the new lab is a 5,000 HP variable speed electric motor. The test loop is rated for 1,100 psig, supporting test conditions up to 1,000 psig discharge pressure. ■

Mitsubishi Strengthens its Chiller Push with Climaveneta Products

Mitsubishi Electric Australia has announced that it will begin selling Climaveneta branded chillers in Australia following its DeLclima S.p.A acquisition. The Mitsubishi Electric Corporation has renamed DeLclima S.p.A., as MELCO Hydronics & IT Cooling S.p.A., and will continue to include the subsidiary Climaveneta S.p.A. The move allows the company to offer a chiller solution across a much broader and more diverse range of projects.

Effectively immediately, all Climaveneta sales, service and spare parts, commissioning and support enquiries are now handled by Mitsubishi Electric Australia. The company's General Manager of Business Development and Operations in Australia, Raja Gounder, said Climaveneta is a well-respected and high-quality chiller brand. "We are proud to be able to add these products to our portfolio," he said.

"It allows us to deliver a comprehensive and versatile range of solutions for our customers, whatever their need and

regardless of whether they are involved in a new-build or retrofit situation."

Mitsubishi Electric has manufactured chillers for over 40 years and has already combined this extensive experience with advanced component technology from the commercial air conditioning sector and introduced the innovative e-series modular chiller range earlier this year.

The purchase of Climaveneta adds over 45 years of experience and knowledge of this industry sector and marks Mitsubishi Electric's full-scale entry into the Australian chiller market.

"We entered the chiller market in Australia with our E-series product earlier this year, and the addition of Climaveneta chillers strengthens our product offering in this segment," Gounder said.

The E-series product and the Climaveneta range make a compelling offering and complement each other with features and specifications that can match almost any application. Each chiller is easily integrated with new and existing systems using BMS control. ■

Boosting Operating Efficiency & Sustainability

Honeywell announced a facility infrastructure modernization project at 21 Federal Aviation Administration (FAA)-operated facilities across the United States. The project will create 95 related jobs over the course of the program and is expected to help the FAA reduce the energy use in those facilities by nearly 10 percent.

The project will be funded through a combination of an Assisting Federal Facilities with Energy Conservation Technologies (AFFECT) Grant from the Department of Energy and a 23-year, \$10.8 million energy savings performance contract (ESPC). The ESPC will enable the FAA to fund the upgrades using annual energy and operational savings guaranteed by Honeywell, eliminating the need for upfront capital investment.

Honeywell will lead work for the multi-

phased, facility infrastructure upgrades to air traffic control towers (ATCT), terminal radar approach controls (TRACON) and air route traffic control centers (ARTCC) at 21 locations across the FAA's Central Service and Eastern Service areas. The project will enable the FAA to address deferred maintenance to critical building systems, reduce overall energy costs and implement renewable energy sources.

"Aging infrastructure can be crippling to an organization's annual budget and hinder its ability to meet organizational goals," said John Rajchert, president of Honeywell Building Solutions. "Our work with the FAA is a prime example of how energy savings performance contracts are a valuable tool to help customers address critical building needs without further hindering capital budgets. That's a winning solution." ■



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Roger Borer is New Executive Officer of BCIA

The Building Controls Association (BCIA) is pleased to announce that they have appointed Roger Borer BA (Hons) as their new Executive Officer. Roger's role in the organisation is pivotal to the operation of the Association and reports to the President Malcolm Anson and the Vice President Jon Belfield.



Roger Borer

The Executive Officer is responsible for running four committees, working groups and general members' meetings. Additionally, Roger will liaise with FETA, external organisations and sub-contractors as well as looking after the financial stability of the organisation.

Furthermore, Roger will also be promoting the BCIA to individuals and the trade press. Acting as first point of contact for the Association, other duties will include the development and execution of all events and day to day administration.

Roger has a vast range of experience making him ideal for

the position. He spent over 30 years employed by J Sainsbury Plc and delivered many complex projects including Year 2000 compliance and setting up Sainsbury's Property Company. An understanding of building controls was pivotal in his success of the delivery of capital construction projects.

Roger is a Fellow of the Institute of Refrigeration (IOR) and has been the Honorary Treasurer of their Executive Council for the past 12 years. Notably, he

has significant experience in working with sub-contractors and consultants which will equip him well for this role.

Malcolm Anson, President of the BCIA says: "We are delighted to welcome Roger on board in his capacity as Executive Officer. Roger will form an integral part of the team at the BCIA and we are all looking forward to working with him. Roger's wealth of experience and industry knowledge will make him a key addition to the Association." ■

Pietro Rossato is the new Group Chief Operations Officer

Pietro Rossato has joined the CAREL group as Chief Operations Officer (COO). A native of Vicenza, 45, Pietro Rossato graduated in electronic engineering at the University of Padova, and over his career has had several different experiences at Italian companies and multinationals, holding positions of responsibility in the areas of logistics, supply chain management and operations.



Pietro Rossato

At CAREL Rossato will be responsible for coordinating and supporting the group's different sites in Italy and abroad (China, Brazil, USA and Croatia) and all activities relating to the supply chain (Purchasing, Logistics, Industrial Projects) in line with CAREL's standards and the continual improvement it is renowned for. ■

Van D Baxter Becomes ASHRAE Director

Van D Baxter, a researcher at the Department of Energy's Oak Ridge National Laboratory (ORNL), has been appointed Director at large for ASHRAE. Baxter, a fellow and life member of the 50,000-member organisation, is a senior research and development engineer in ORNL's Energy and Transportation Science Division.



Van D Baxter

He works in the Building Equipment Research group focusing on heating, ventilating, air-conditioning and refrigeration technology and water heating

systems. Van D Baxter, a researcher at the Department of Energy's Oak Ridge National Laboratory (ORNL), has been appointed director-at-large for ASHRAE. Baxter, a fellow and life member of the 50,000-member organisation, is a senior research and development engineer in ORNL's Energy and Transportation Science Division. He works in the Building Equipment Research group focusing on heating, ventilating, air-conditioning and refrigeration technology and water heating systems. ■

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Time Honours Guus Velders of RIVM

Time has named Professor Guus Velders of RIVM as one of the 100 most influential people in the world. Velders was honoured for his work in establishing the basis for the global climate agreement that was signed in October 2016 in Kigali, Rwanda. Over the past years, working together with American researchers, Velders showed that hydrofluorocarbons (HFCs) have a major impact on the climate. These compounds are used in refrigerators, air conditioners, and insulation materials. In Kigali, Rwanda, world leaders agreed to greatly reduce the use of these greenhouse gases in the coming decades. As a result of this preventive agreement, the contribution of HFCs to climate change will remain limited and be reduced to less than 0.1°C in 2100, in comparison to a maximum of 0.5°C without the agreement.

Due to this contribution, *Nature*, a leading scientific magazine, has already named Velders as one of the 10 most influential scientists in 2016. RIVM Director-General André van



Guus Velders

der Zande awarded him the RIVM Jenner medal for his breakthrough scientific research. Velders has also just been appointed to the position of Professor of 'Air Quality and Climate Interactions' at Utrecht University.

In the coming years, Guus Velders will be working together with his colleagues to further strengthen the scientific basis behind climate policy. With the help of the data and models of RIVM and Utrecht University, he intends to monitor the Paris climate agreement. This will enable RIVM to assist governments and businesses to comply with the national or

international climate targets.

Velders is also researching the effect of climate change and climate measures on air quality and vice versa: he is investigating to what extent particles in the air contribute to air pollution as well as climate change. The insights provided by this research will contribute to better air quality as well as to realising the climate goals. ■

Toshiba's SMMS-e VRF Achieves Unique Hat-trick

Toshiba's ground-breaking VRF system, SMMS-e, has achieved a unique triple success, winning the top accolade for air conditioning innovation in three of the industry's major awards. The pioneering VRF system completed the remarkable hat-trick by being crowned Mechanical and Electrical Building Services Product of the Year 2016 in the H&V News Awards for Excellence.

Toshiba was presented with the award at The Grosvenor on London's Park Lane, in front of an audience of more than 1000 leading lights from across the industry. It follows similar success in the National ACR Awards and ACR News Awards earlier this year. The judges said: "Toshiba's SMMS-e achieves best-in-class energy efficiency by combining a vast number of innovative and proven technologies in one product." It is the only VRF in the market with all outdoor units exceeding seven ESEER (European Seasonally Adjusted Energy Efficiency Rating). David Dunn, Toshiba Director and General Manager, said: "We are delighted that SMMS-e has again triumphed, and gained its third major accolade this year for innovation and energy performance. Independent endorsement by no fewer than three separate industry judging panels confirms our belief

in the product as industry-leading and in the most important and competitive sector of the air conditioning industry."

At the heart of SMMS-e are innovations in three core technologies – the compressor, heat exchanger and advanced



Celebrity Rugby star Austin Healey, who hosted the awards, pictured with Toshiba's Oliver Sanders and Wayne Dolley, following the award presentation by Paul Gordon of sponsor SIG Mechanical and Electrical

intelligent control – which combine to deliver outstanding efficiency and comfort for building occupants. A new rotary compressor, developed and manufactured by Toshiba, uses a two-stage compression process for improved efficiency and performance. Wear surfaces on compression vanes are treated with a high-tech Diamond-Like Carbon (DLC) coating, giving outstanding hardness, wear resistance and reliability. It enables a

significant increase in compressor rotation speed, resulting in a higher displacement volume – up to 50per cent greater than for the previous generation of VRF systems. This enables a higher duty to be obtained from a smaller compressor, with less power. David Dunn: "As I have said before, we are thrilled with the recognition, however, we are not resting on our laurels. The SHRM-e VRF, to be launched later this year, will build on the success of the SMMS-e, and feature further innovations in technology that will contribute to even higher efficiencies and ease of installation and servicing." ■



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office@bitzer.in
customer@bitzer.in

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Bitzer India Pvt.Ltd.
BITZER India Pvt. Ltd.
D-20/1, Phase-I
Okhla Industrial Area
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Tel: +91 (0)11 2681 0141
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Air Handling & Air Distribution in HVAC System

Air Handling Unit (AHU) is basically used to condition indoor air with their heating, cooling, humidification and de-humidification functions in a HVAC system...

Basic Components of an Air Handling Unit

An air handling unit consists of few important components. Those are as follows:

Casing

Casing is the insulated enclosure of an AHU which keeps all the system components of an AHU safe inside and prevent the heat gain or loss from it. A schematic diagram of a typical air handling unit is shown in Fig. 1.

Duct

Two types of ducts are used in an AHU. These are the supply air duct and

Air conditioning is the process of conditioning of indoor air to maintain its temperature, humidity, velocity and cleanliness inside the room or desired location at a desired level for human comfort or any industrial process. Air handler or air handling unit (AHU) is one of the most essential and major parts of an

air conditioning system. AHU is a large metal box that consists of a blower, heating or cooling elements, filter racks or chambers, sound attenuators and dampers. AHU is basically used to condition indoor air with their heating, cooling, humidification and de-humidification functions in a HVAC system.



Table 1: Different types of filters

Usage	Class	Performance	Performance test	Particulate size approaching 100% retention
Coarse filters (used as Primary)	G1	65%	Average value	$>5\ \mu\text{m}$
	G2	65–80%	Average value	$>5\ \mu\text{m}$
	G3	80–90%	Average value	$>5\ \mu\text{m}$
	G4	90%–	Average value	$>5\ \mu\text{m}$
Fine filters (used as Secondary)	M5	40–60%	Average value	$>5\ \mu\text{m}$
	M6	60–80%	Average value	$>2\ \mu\text{m}$
	F7	80–90%	Average value	$>2\ \mu\text{m}$
	F8	90–95%	Average value	$>1\ \mu\text{m}$
	F9	95%	Average value	$>1\ \mu\text{m}$
Semi HEPA	E10	85%	Minimum value	$>1\ \mu\text{m}$
	E11	95%	Minimum value	$>0.5\ \mu\text{m}$
	E12	99.5%	Minimum value	$>0.5\ \mu\text{m}$
HEPA	H13	99.95%	Minimum value	$>0.3\ \mu\text{m}$
	H14	99.995%	Minimum value	$>0.3\ \mu\text{m}$
ULPA	U15	99.9995%	Minimum value	$>0.3\ \mu\text{m}$
	U16	99.99995%	Minimum value	$>0.3\ \mu\text{m}$
	U17	99.999995%	Minimum value	$>0.3\ \mu\text{m}$

return air duct. The cool and conditioned air is supplied to desired locations from the AHU by the supply air duct, while the hot air from the room is again returned back to the air handling unit through return air duct. There is one main supply duct that is then divided into various small ducts those lead to all the rooms that are to be maintained at a specific condition. Similarly, the return ducts from all the rooms also end into one main duct. Insulating materials are used to cover those ducts to prevent the heat gain or loss from these ducts and the ducts are designed in such a fashion that the distribution should be equal to all the rooms and wastage should be minimal.

The Mixing Chamber

In this section, the fresh air from the environment is mixed with return air from the room. This is done to minimize energy consumption by taking advantage of the heating/cooling ability of the return air. In this system, fresh air is only required to supply the air change rate needed for comfort.

Damper openings are generally controlled manually or by servo motor. But the main issue is to allow air to circulate freely and facilitates installation in closed ducts. Thus, dampers are designed to allow synchronous control. The three-way mixing chamber has been designed for similar purposes. However, this system

includes a fan for return air. The desired portion of return air is given back to the system and the remainder can be exhausted.

Filters

Filter is one of the very important components in an air handling unit. Filters are basically used to remove particles and contaminants of various sizes from the air. These air filters are usually placed at initial stage of an AHU to keep the downstream components clean. Generally, filters are placed in two or more successive stages with a coarse grade filter in front of a fine grade filter. Sometimes, final filtration medium is also there for further cleaning of the air.

Different types of air filters are used in an AHU and their performances are listed in table 1. The type of air filter being used is very much dependent on the application of the system.

Air filters may also be classified according to their applications such as:

- **Panel Filter**

These types of filters are flat and rectangular in shape and provide a low efficiency filtration. The high velocity filters are arranged vertically whereas the low

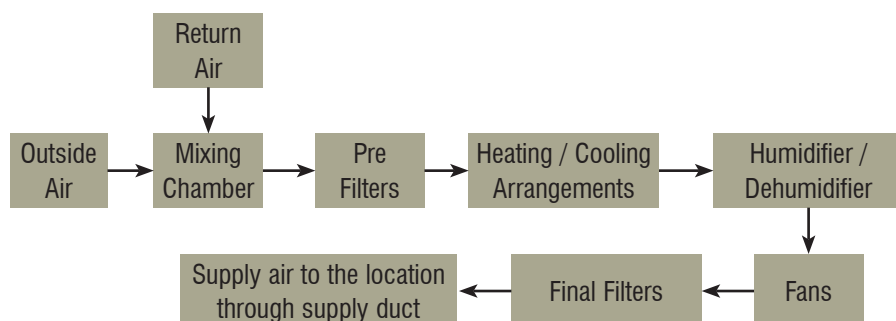


Figure 1: Schematic diagram of an air handling unit

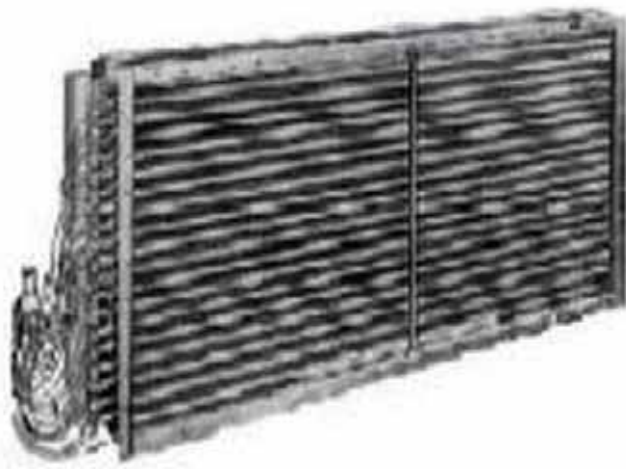


Figure 2: A Heating Unit



Figure 3: A Cooling Unit

velocity filters are arranged in V shape. Typical air velocity through these types of filters ranges between 2-3 m/s.

- **HEPA Filter**

HEPA Filters are very efficient and is able to achieve efficiency up to 99.97%. These filters are efficient in removing minute particles and airborne bacteria from the air. It is usually used in clean room applications such as semiconductor production floor, operation theaters and places undergoing critical processes.

- **Electrostatic Filter**

Electrostatic Filter is used to remove particles from the air by using highly charged electrodes that ionized the air. Bag Filter is able to remove dust particles and is thrown away after use. Roll Filter is used for high velocity filtration where the used

part is rolled up automatically or manually.

Cooling / Heating Arrangements

Temperature control is one of the major factors in an air handling unit. The perfect temperature for human comfort generally varied between 18°C – 23°C. So, for human comfort this temperature must be maintained by an AHU. Therefore, a cooling or heating or arrangement for both purposes is provided with the AHU. Heating and cooling is, generally, done by either direct type heat exchangers or indirect heat exchangers. Direct type heat exchanger includes burning of gaseous fuel in the air stream for heating or evaporator for cooling purpose. Electrical heater or heat pump can also be used to serve the purpose. While, in indirect heat exchangers hot water or steam or chilled water in pipe line can be used. These pipe lines are manufactured from copper and fins are provided which is made from copper or aluminum. Typical heating and cooling units have been shown in figure 2 and figure 3 respectively.

Humidifier / Dehumidifiers

Another very important parameter while designing an air handling unit is humidity. A

humidity comfort level in the range of 45% - 55% relative humidity (RH) should be maintained. The humidity of the air sometimes goes very low causing discomfort to the occupants during the peak season of winter or the vice versa during summer. That makes the manufacturers to think about the necessity of humidifier in air conditioning system. Figure 4 shows a pictorial view of a humidifier. The humidity of the air can be increased or decreased according to the requirement using the humidifiers or de-humidifiers. Various types of humidifier are commonly used in an AHU. Those are:

- **Spray Type**

Spray type humidifier has a header and spray nozzles that spray water with a pressure of 15 psi or more.

- **Steam Pan Type**

Steam Pan Type humidifier has a pan and a heating coil to heat up the water of the pan. The evaporation of water caused by the heating will increase the humidity level of the surrounding air.

- **Steam Grid Type**

Steam Grid type humidifier has tiny holes on the pipe to distribute the steam that flows through it. In this case, the water that is heated up to produce the steam to be supplied to the grid is conditioned to prevent odor being discharged to the room.

Fans

Another very important component in an air handling unit is fan or blower. The



Figure 4: Humidifier

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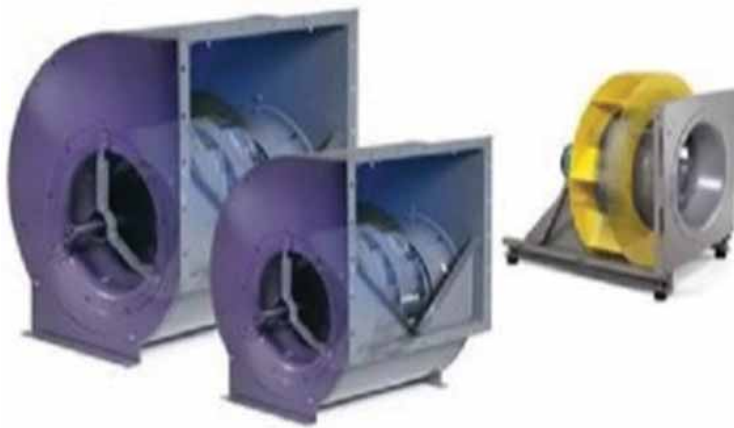


Figure 5: Fan unit

hot return air from the room is first sucked and then blows it over the cooling coil where the hot air is cooled and then that is sent to the room to be conditioned. This is done by the fan or blower arrangements in an AHU. In general, two types of arrangement of fan are there in an AHU: draw through arrangement and blow through arrangement. The return air is sucked through the filter, the cooling coil and humidifier in the draw through arrangement. While passing through the filters, humidifier and cooling coil, the air gets conditioned and then it is sent to the required location. But, in case of the blow through arrangement the fan absorbs the return air and blows it over the air filter and the cooling coil. The air then flows to the rooms to be air conditioned. The draw through arrangement is used more commonly due to its compactness. The fans that are used in AHU are basically of centrifugal types. Figure 5 shows the pictorial view of fan unit used in an air handling unit.

Difference between Air Handling Unit and Fan Coil Unit

Though both air handling unit (AHU) and fan coil unit (FCU) serves the same basic function of cooling in a HVAC system, there are few differences between those two units. Those are:

- AHU is generally bigger system than a FCU.
- AHU is more complex than FCU.
- AHU is generally used in bigger establishments
- AHU systems needs ducting whereas,

FCU does not need any duct work.

- AHU system takes outside air into the system whereas, FCU just recycles air.
- AHU is used for filtering, heating or cooling and humidification or dehumidification of air while FCU just cools or heats air.
- AHU is less noisy than FCU.

Air Distribution System

After transmitting conditioned supply air from the air handling unit to the room, it has to be distributed to the conditioned space. So, it is very important to design the air distribution system properly. It is found that sometimes the efficiency of an air distribution system becomes low in the range of 60 – 75% due to the poor design. There is a scope of improving the efficiency upto 80% or more with proper installation

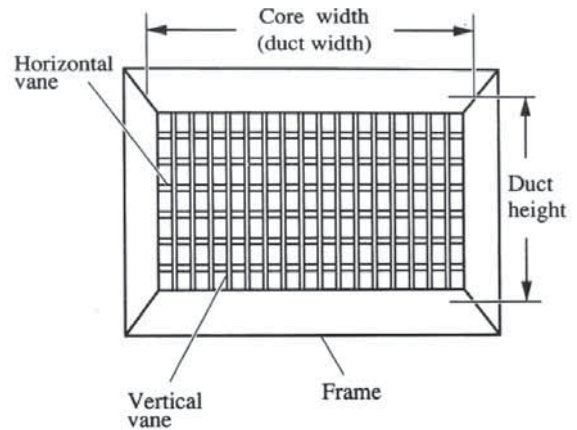


Figure 6: Grilles and Registers

of distribution system. Proper designing and installation of the air distribution system can save money up to 50 – 200\$ per year. Moreover, efficient distribution system also reduces the equipment size.

Types of Air Distribution Devices

Different types of air distribution devices are being used in HVAC systems recently. These are:

- Grilles and Registers

Grilles are the outlets for supply air or inlets for return air whereas, registers are the grille with a volume control damper. Figure 6 shows the front view of a supply air grille with horizontal and vertical vanes that are basically used for deflecting airflow. Grilles have a comparatively lower entrainment ratio, greater drop, longer throw and higher air velocities in the

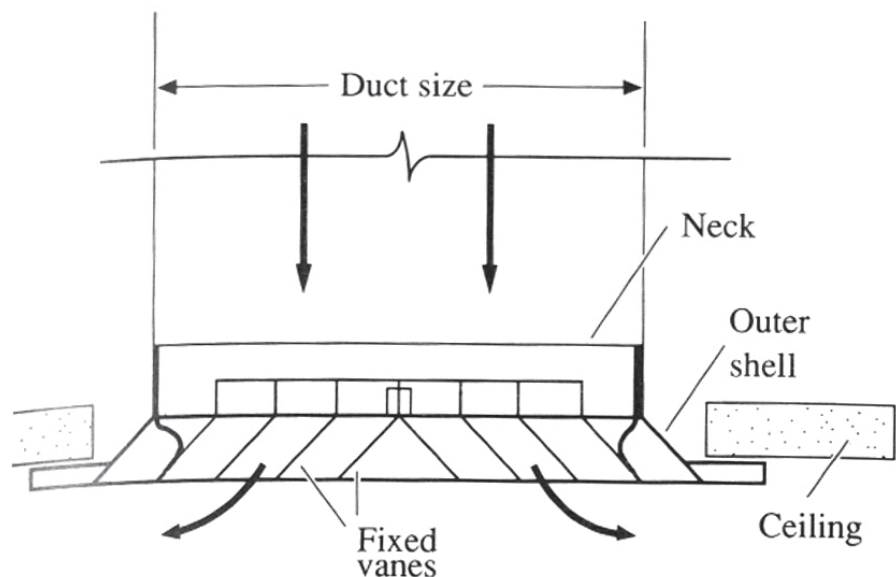


Figure 7: Ceiling Diffuser



Figure 8: Slot Diffuser

occupied zone compared to slot and ceiling diffusers. The performance of the grilles are specified in terms of core size or core area, volumetric flow rate of air, effective air velocity, total pressure drop, throw and noise levels. They can be mounted either on the sidewalls or in the ceiling.

- **Ceiling Diffusers**

A ceiling diffuser consists of concentric rings or inner cones made up of vanes arranged in fixed directions. Ceiling diffusers can be round, square or rectangular in shape. Square and rectangular ceiling diffuser has been shown in figure 7. A square diffuser is the most commonly used diffuser for supplying air. The supply air is discharged through the concentric air passages in all directions. The adjustable inner cones or the deflecting vanes are provided to change the air distribution pattern. These types of diffusers are normally mounted at the center of the conditioned space and those can provide large entrainment ratio and shorter throw for conditioned spaces with low head space.

- **Slot Diffusers**

Slot diffusers are made up of plenum box with single or multiple slots and air deflecting vanes. These types of diffusers are mounted on either side of walls or in the ceiling. Linear slot diffusers are mounted on the sidewalls of the conditioned room. These are used for supplying both supply air and return air. These diffusers are particularly suitable for large open-spaces as long as 30 meters in length that require flexibility to suit changing occupant distribution. Figure 8 shows the photograph of conditioned space with linear slot diffusers mounted on the ceiling.

Types of Air Distribution Systems

Two types of air distribution system are commonly used for maintaining the room conditions. Those are:

- **Constant Volume**

Constant-volume systems are operated at a constant airflow rate and only the temperature varies to maintain the zone set point. Constant-volume units can be

used in single-zone or multi zone applications. This type of system can use single duct or dual duct for the distribution of air. A single-duct system provides ventilation and cooling to the conditioned space. If heating is required then a heating unit is provided in the terminal unit or a separate system for heating may be introduced. A dual-duct system can distribute both hot and cold air by using a single fan to move air through both cooling and heating coils in the air handler. The supply air can be distributed by separate duct to the desired locations depending on the zone requirements. Another constant-volume system is the multi zone unit. The multi zone unit supplies air to several zones from a centrally located air-handling unit. Individual zone requirements are met by mixing cold and warm air through dampers in the air handler. The conditioned air is then distributed to the zones via single ducts.

- **Variable Air Volume (VAV)**

A variable air volume (VAV) can vary the air flow at a constant temperature. In a VAV system one supply duct distributes supply air at a constant temperature. As the supply air temperature is constant, the air flow rate must vary to meet the rising and falling heat gains or losses within the thermal zone served. This type of system has many advantages over constant volume system. In this system, the supply air flow rate can be varied. The precise control of temperature, reduced compressor wear can be achieved in this system. This system consumes less power to run the system fans and makes less noise compared to constant volume system. ■

Bijan Kumar Mandal
Department of Mechanical
Engineering
Indian Institute of Engineering
Science and Technology,
Shibpur, Howrah



Ranendra Roy
Research Scholar, Indian
Institute of Engineering
Science and Technology,
Shibpur, Howrah



Bitzer Warns of Fake Refrigeration Oils

The long-standing company BITZER warns users against imitation oils. In Vietnam and Korea, counterfeiters partly disguised their imitations with the logo and name of the specialist for refrigeration compressors. These forgeries can lead to compressor breakdown, in contrast to the use of BITZER Original Refrigeration Oils...



BSE32 matches the use of HFKW and HFO refrigerants in BITZER reciprocating compressors, whereas BSE170 is used in BITZER screw compressors

Product pirates not only sell counterfeit compressors, they also bring low-quality oils onto the market. In Asia, for example, counterfeiters partly disguised their imitations with the BITZER name and logo, presenting major risks. BITZER recently discovered several fake oils in Vietnam: a local company has illegally been declaring and selling containers with low-quality oil as original products from BITZER. According to the label, the high-quality oils B320SH, BSE32, BSE170 and B100 should be in the containers. However, they contained oils of inferior quality whose chemical formulation differs greatly from the high quality of the originals.

BITZER has investigated the counterfeiting and expressly warns customers against the possible risks associated with their use. The viscosity characteristics, moisture content and chemical formulation are very different from the original products.

CAP OF BSE32 AND BSE170: VAPOUR-TIGHT IS THE ONLY ORIGINAL PACKAGING



The vapour-tight packaging (here: caps of BSE32 and BSE170, used in Europe) gives evidence of the oil being a BITZER Original

Programmed Damage

Using the fake product can lead to insufficient lubrication of compressors, chemical reaction, destruction of elastomers and thus to great damage. In the imitation oil of the type BSE170, the moisture content exceeded the permissible values significantly. It was three times higher than the permissible value. High moisture content in polyolester oils like BSE170 is particularly critical because it leads to hydrolysis with the result of acid formation in the refrigerant circuit.

This in turn causes copper plating and thus damage of critical moving parts like roller bearings as well as possible motor burn-out. This can in consequence trigger very high costs for compressor exchange and measures for system dehydration and acid catching.

Original Bitzer Refrigeration Oil

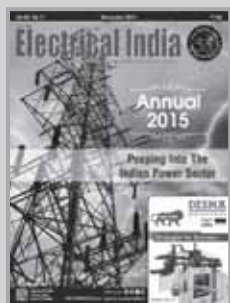
Original BITZER lubricants feature lowest moisture content (lower than specified in standards) and specific properties optimised for BITZER compressors. Their chemical compatibility is extensively tested including distinct compressor construction materials introduced for use with the latest low-GWP HFOs and HFO/HFC blends. Due to their specific tribological characteristics, BITZER oils guarantee highest service life of the compressors. The outstanding lubricity and superior viscosity/temperature behaviour ensure reliable compressor operation and sufficient oil circulation in the circuit.

BITZER Refrigeration Oils are subject to BITZER Quality Assurance and are delivered in metal packages which allow no moisture to ingress, even after longer periods of storage. Furthermore, safety data sheets are available as standard in several languages for all BITZER oils.

Only Originals Are Safe

The specialist for refrigeration compressors condemns product piracy and warns against the associated risks. The use of counterfeit oils has a negative impact on the performance, safety and service life of BITZER compressors. Users should avoid these risks.

In the end, the consequences of supposedly cheap forgeries are by far more expensive than the expected savings. The Original Refrigeration Oils certified by BITZER offer users more safety and have positive effects on the compressor's life. Customers who have concerns about the origin of their lubricant are invited to contact their local BITZER representative for advice. ■



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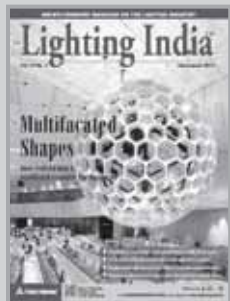
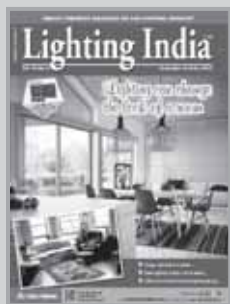
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Improving Indoor Air Quality

We spend more than 85% of our lives indoors, be it our own bedroom, dining room, classrooms, college libraries, restaurants, and the list is endless. Therefore, it is vital to maintain an excellent quality of indoor environment. Researches have shown that offices that make diligent efforts towards maintaining a good indoor environmental quality have happier, healthier, more intelligent employees and this leads to higher productivity...

Are we breathing right? Is the indoor air more pure and better than outdoor air? Can air conditioner help in purifying air? Absolutely not! Especially in metro cities like Delhi that has emerged as the most polluted city in the world. People living in crowded metropolitan cities are unaware that they are breathing in air that is far more polluted

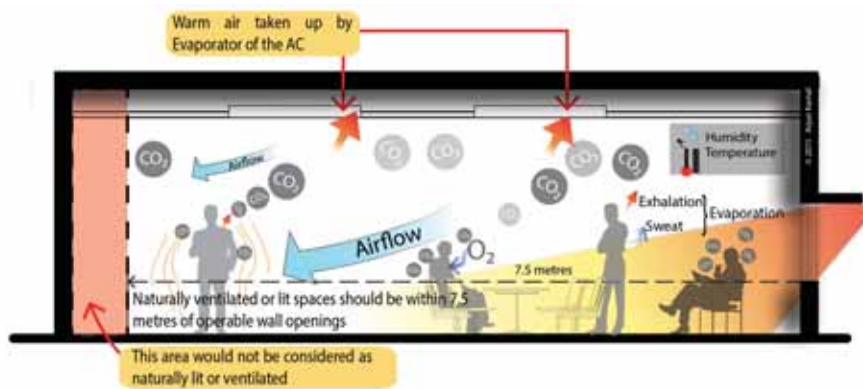
than one can ever imagine. This is wreaking havoc with their minds and the ability to think and behave, how they differentiate between wrong and right. Poor quality of indoor environments causes various health problems and also results in the sick building syndrome. What's even more disturbing is that indoor air can be much more polluted than the

outdoor air, therefore it is extremely essential to know about its quality. One should learn how to enhance the quality through various healthy practices.

We spend more than 85% of our lives indoors, be it our own bedroom, dining room, classrooms, college libraries, restaurants, the list is endless. Therefore, it is vital to maintain an excellent quality of indoor environment. Researches have shown that offices that make diligent efforts towards maintaining a good indoor environmental quality have happier, healthier, more intelligent employees and this leads to higher productivity. Schools following this practice have smarter students with high enthusiasm towards academics and other extra-curricular activities.

Our body needs a certain amount of balance between carbon dioxide (CO₂) and oxygen (O₂). When they are in balance





within a specific range of ambient temperature, the body functions in the most efficient way. The person remains calm and does work faster than he would do in a polluted environment or in an environment that has undesirable temperature.

When we breathe in polluted air, the brain gives the body signals that something is wrong with the environment making us feel restless and uneasy. People who continue to work or live in such environment become the victim of stress and depression. This results in lower productivity in a given period of time. Often, crime also roots from such areas having inhospitable environments.

There is a simple method to understand this phenomenon. A brain can do a limited amount of work in a given period of time. Picture this. Everything is in balance, the

air temperature and the pollution levels. Your body will feel right, you will do your work without getting stressful or uneasy. On the other hand, when the pollution levels and temperature is very high, your brain will have to do more work to make you feel better. The energy that would have gone completely in doing creative and productive work would be lost in regulating your body's temperature and stress hormones. Here is where the term IAQ i.e. indoor air quality comes to effect.

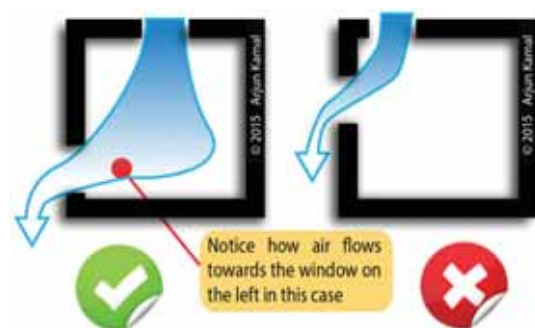
Indoor air quality is a part of indoor environmental quality which comprises of thermal comfort, lighting, visual quality and acoustics too.

Let's go back to our school days. In our science class we studied about the effect of carbon dioxide on the human bodies. When the concentration of carbon dioxide increases in our bloodstream at

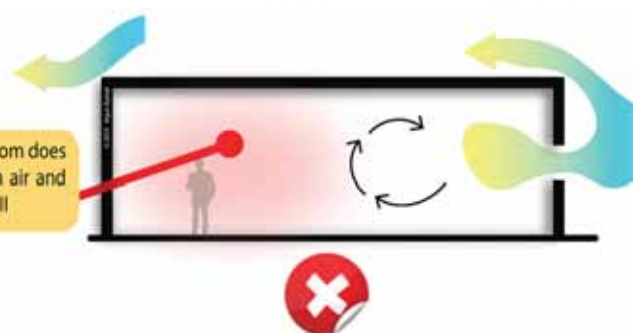
levels above 1%, dizziness occurs. At levels of 5% the body experiences more dizziness, shortness of breath and panic attacks. In high concentrations this gas can cause drowsiness, suffocation, headache, fatigue and unconsciousness.

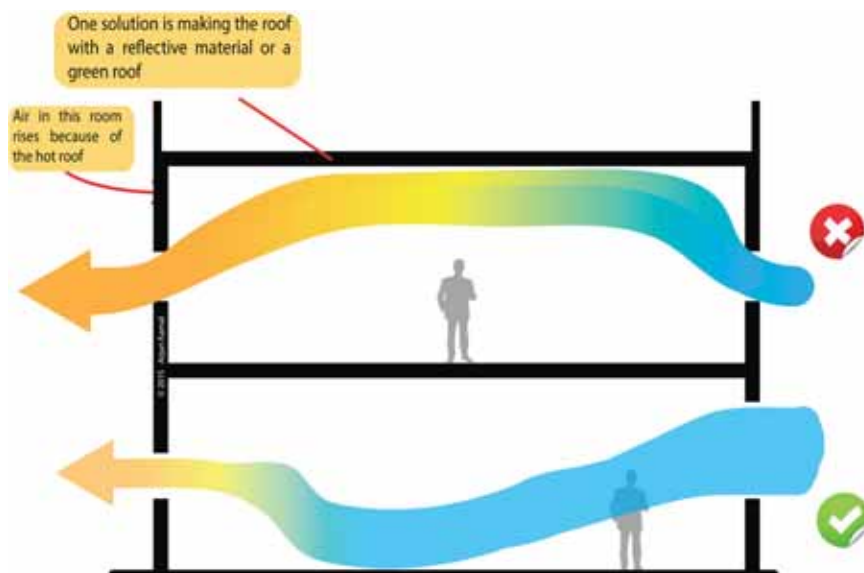
In an indoor environment, the CO_2 that we exhale must be taken out of the room. CO_2 as we know is a harmful gas for human beings which is also known for the notorious green house effect.

Let's understand how heat and dust move through air. It's a fundamental law of nature that energy always travels from high concentration to lower concentration.



This portion of room does not get any fresh air and will give foul smell





When a room is cooler than outside, then heat energy from outside will enter in. Similarly, during winters if the room is warmer, then heat will flow from interior to exterior. Same principle applies for dust particles and pollutants. If there is a nallah near a roadside, we can smell foul air because the nallah is the source of that bad smell (having high concentration) and air on the road has low/no speck of the foul air particle of nallah in it. So, the polluted air moves from the nallah to the roadside air.

In the same way, in our rooms, over a long period of time dust and pollutants get accumulated between the tiny gaps in the fibres of bed sheets, curtains and other objects like soft toys, canvas paintings, carpets, cushions, wall hanging made of jute, etc. When we breathe in, these dust particles move into our lungs which were free from it because of low concentration.

Dust also gets collected in the ventilation systems e.g. the vents of the air conditioning ducts. Moreover, this situation when gets worsened with moisture getting accumulated, leads to growth of harmful microbes like moulds and bacteria in the buildings which leads to deterioration of indoor air quality.

Dust allergies are actually allergies to dust mites — microscopic pests that need moisture to survive. Dust mites feed on human skin and live in bedding, pillows, mattresses, stuffed toys, upholstery, and carpets. Upholstered furniture should be

vacuum cleaned regularly to prevent accumulation of dust. Bed sheets and cushion covers should be washed weekly to keep off dust. To prevent building of moisture in your building, keep a regular check on leakages during the seasons of rains and high humidity.

You are more prone to wheezing, coughing and asthma if your house has dampness even if there is no growth of moulds. Roofs, foundations and basements should be checked at least once a year for leaks or moisture. Wet rooms like bathrooms, kitchens and toilets should be vented properly. Use a chimney in your kitchen to keep fumes and smoke emissions due to cooking away from entering other habitable areas in your house.

All the windows of your house should be openable and placed efficiently to facilitate natural ventilation with regular air changes as well as natural light. The national building code prescribes areas within 7.5 metres of windows as naturally lit.

Air can be further prevented from getting polluted by using a decent particle filter or air cleaner in the air handling system to keep the air dust free. It also keeps away dust from entering the ductwork. Regular cleaning of filters should be done. They should also be checked periodically for replacement.

Besides air quality, maintaining an ambient temperature is also necessary to

provide an ideal indoor environmental quality.

Whatever work we do, whether it is lifting a book off the table or walking a few steps to switch on the light, produces heat. Studies have shown that only 20% of the energy is used in doing any work by our body. The rest 80% is dissipated as heat. If this heat is not taken away/off from our body, then we feel uncomfortable.

You have all experienced this. We suddenly feel happy and relieved if we step into an air-conditioned showroom after walking in an uncomfortable hot outdoor environment. To dissipate the heat naturally from the human body, windows should be kept open to ensure cross ventilation in non AC rooms. The placement of the windows should be such that the air flows across the human body height and not above it as in near the ceiling.

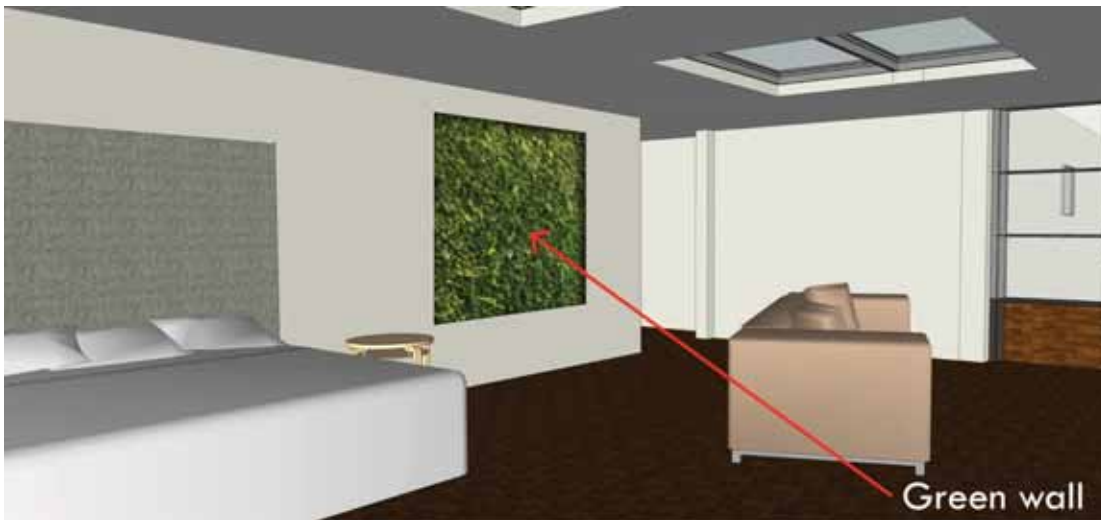
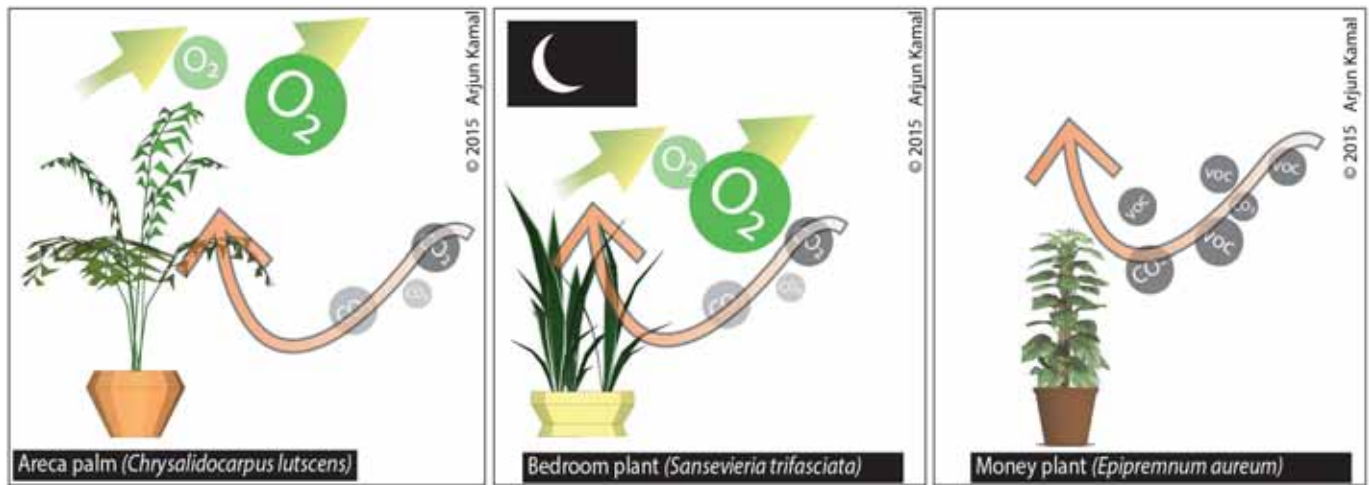
If the air will flow through the surface of the body then the heat will be readily and easily taken off. Moreover, CO₂ inside would also be replaced by outside fresh air through ventilation.

Ventilation is a necessary component for maintenance of indoor environmental quality. It is measured by the rate of flow of outside air getting inside the building environment. It is typically expressed in cubic feet per minute (cfm) or litres per second (L/s). Other units to assess ventilation rates are per person (cfm/p), per unit floor area (cfm/ft) or air changes per hour (ACH).

National building code of India prescribes following air change rates for different building types

Building type	Air change per hour
Bedrooms	2-7
Bathrooms	6-10
Living rooms	3-6
Offices	6-10
School rooms	5-7
Toilets	6-10

ASHRAE (American Society of Heating, Refrigerating, and Air-Conditioning Engineers) prescribes 15cfm of outdoor air per person as the minimum ventilation rate to decrease transmission of microbes



effective regulation of indoor air quality through removal of volatile organic compounds (VOCs) and other harmful gases. These green walls are walls which are covered with vegetation. VOCs are known to cause pollution which leads to respiratory problems and allergies.

and other agents of infection. This means if there is one person in the room, then 15 cubic feet of fresh air per minute should enter the room.

You should keep opening windows regularly for proper ventilation of your rooms. Exhaust fans also help a lot in removal of foul air, especially in bathrooms and toilets.

Human body needs oxygen and air at ambient temperature to function in the most efficient way. Air conditioners and natural ventilation can be used for maintaining ambient air temperature. But what about fresh air especially on days when there is lot of dust and pollution levels are also high? You can switch on your ACs for maintaining a cool and calm room environments but what about oxygen levels in the room? We must devise ways to increase oxygen levels in the room.

Plants are often used indoors for aesthetics. But do you know that you can

also grow fresh air with three commonly available plants? These are

- Areca palm (*Chrysalidocarpus lutescens*)
- Mother in law's tongue (*Sansevieria trifasciata*)
- Money plant (*Epipremnum aureum*)

Areca palm converts CO_2 to oxygen. One should take these plants outdoors every three to four months. Mother in law's tongue, which is also known as bedroom plant can convert CO_2 to oxygen at night. Formaldehydes and other harmful volatile chemicals in air can be removed by Money plant. Plants can also be incorporated in a vertical fashion in green walls so as to provide effective regulation of indoor air quality through removal of volatile organic compounds and other harmful gases. These compounds are known to cause pollution which leads to respiratory problems and allergies. Plants can also be incorporated in a vertical fashion in green walls so as to provide

Such compounds are found in paints and other building materials, like, wood, steel, glass, plastic, leather, PVC, etc. While buying materials for your home, do check the VOC content in the technical specifications list on the packet. It should be within permissible limits.

Therefore, use these techniques in your rooms to breathe fresh and live for long. Lots of researches and studies have shown that the air quality also shapes our DNA which eventually influences our personality and our behaviour. Now you can very well imagine what clean air can do to us. ■

(All illustrations drawn by author)

Arjun Kamal
Architect and Interior
Designer,
Vastukala Academy,
New Delhi



Precise Measurement of Volume Flows in Commercial Buildings

The volume flow hood testo 420 sets new standards regarding weight and precision. With only 2.9 kg and ergonomic handles, frequent or difficult measurements too, can be carried out comfortably, without inducing fatigue, and therefore safely..



Differential pressure measurement with connection hose

For humans to feel comfortable in a room, the air quality, among other factors, must be ensured. Assuming closed rooms, this quality results from the volume flows of the installed VAC system. In order to respect the regulations for Indoor Air Quality, regular checking of the total volume flow of the VAC system is necessary.

Challenge

A high CO₂ concentration in a room leads to fatigue, and can even cause illness. For this reason, sufficient oxygen must be introduced by an exchange of fresh air, especially in commercial buildings, offices and schools. The workplace directive DIN EN 13779 even requires certain outside air flows, depending on the



activity of the persons in the room:

- 20-40 m³ /h per person with a predominantly sitting activity
- 40-60 m³ /h per person with a predominantly non-sitting activity
- Over 65 m³ /h per person with a heavy physical activity.

In order to meet these norms, the air conditioning technician regularly tests the total volume flows of the VAC system. To do this, up to fifty measurements at different outlets can be necessary, which means a high physical burden. In addition to this, these rooms have large swirl outlets installed as standard, which do not blow the air into the room straight, but instead continually swirl it, consequently air flows are often incorrectly measured at these locations. And this complicates the determination of the volume flow substantial.

Solution

The volume flow hood testo 420 sets new standards regarding weight and precision. With only 2.9 kg and ergonomic handles, frequent or difficult measurements too, can be carried out comfortably, without inducing fatigue, and therefore safely. It converts the turbulence at the swirl outlets into an almost uniform air flow, leading to a considerably more accurate measurement. In addition to this, the hood records the ambient climate using an integrated temperature and humidity sensor as well as an absolute pressure sensor.

The application is simple too: Funnel-shaped tension rod sockets support easy and quick set-up, and the trolley included in delivery ensures safe transport. Via Bluetooth App integration, smartphones and tablets can be used as a second display and remote control. After the measurement, the App allows the finalization and sending of the measurement protocol directly on site. Differential pressure or Pitot tube measurements are also possible with the removable measuring instrument by simply entering the duct geometry. With the volume flow hood testo 420, users can quickly and accurately fulfil the legal regulations on Indoor Air Quality for ventilation and air conditioning systems in commercial buildings and schools.

Advantages

- More precise measurement of volume flow at larger swirl outlets
- Uniquely light, with only 2.9 kg
- Fast set-up, easy handling and convenient operation thanks to mobile App

For more information write to

info@testoindia.com

Companies Decry Trump Plan to Eliminate Energy Star Program

President Donald Trump's proposed budget would eliminate funding for Energy Star, which encourages efficiency in major appliances, office equipment, lighting and home electronics...

More than 1,000 US companies, including some of the nation's largest manufacturers, are urging Congress to preserve the 25-year-old Energy Star program to promote efficiency in home and business products. President Donald Trump's proposed budget would eliminate funding for Energy Star, which encourages efficiency in major appliances, office equipment, lighting and home electronics. Companies including United Technologies Corporation, Ingersoll Rand and Staples call the program a model for successful collaboration between the public and private sectors. In a letter to the Trump administration and congressional leaders, the companies say Energy Star "should be strengthened, not weakened" to encourage businesses and consumers to conserve energy.

United Technologies is the parent company of Carrier heating and cooling, Otis elevators and Pratt & Whitney engines, while Ingersoll Rand is the parent of Trane heating and cooling. Other companies signing the letter include LG Electronics USA, Panasonic Corporation of North America, Samsung Electronics

America and Nest thermostats, owned by Google.

Energy Star, begun in 1992, is known for its blue-and-white star logo that appears on hundreds of products from washing machines to furnaces and computers. The program costs about \$50 million per year to administer while saving consumers more than \$34 billion per year in reduced energy costs. The White House proposed eliminating the program, along with other programs at the Environmental Protection Agency in its 2018 budget plan. "I don't know who recommended shutting down this program to the President, but I can assure you it was bad advice that would hurt American businesses, consumers and our overall economy," said Kateri Callahan, President of the

Alliance to Save Energy, a Washington-based advocacy group. The alliance organized the business letter.

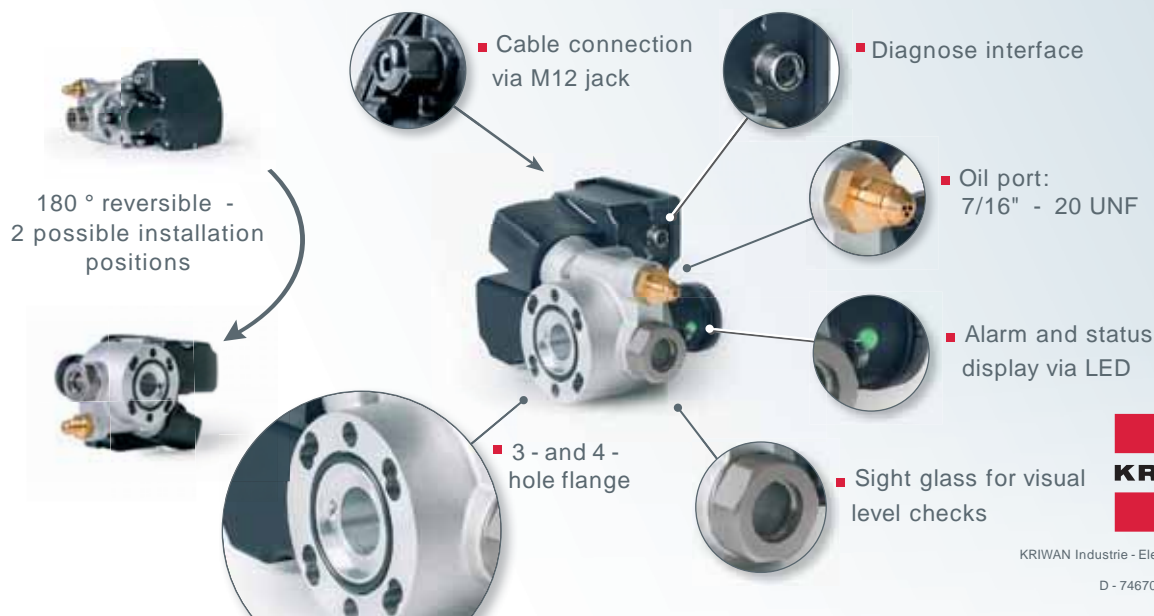
"This letter demonstrates the enormous business support for a venerable public-private partnership and sends a clear directive to Washington: Keep the Energy Star program going and growing," Callahan said. ■



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“There is a lot of potential for the cold storage industry in our country”

Due to the lack of infrastructure and supply chain efficiency the sector has seen a setback. Primarily, we need to work on providing proper and adequate infrastructure for food storage, processing and cold chain logistics. The government must take measures to provide adequate facilities that streamline the process for a better output, states

Ravichandran Purushothaman, President, Danfoss Industries Pvt Ltd in an interaction with **Supriya Oundhakar...**

Please take us through Danfoss journey in India.

We started our operations in 1999 in India primarily as sales company selling global products in India. We have come a long way since and have witnessed a steady growth. We have also evolved into a full-fledged facility with a manufacturing unit for catering to India and also exporting to other countries, a strong R&D team which develops products for India and global and a complete supply chain to meet the requirements. What was initially a \$7

million company with 30 people is now an 800 people strong organization with a turnover of around \$120 million. When we began operations, we used import 100 per cent, now close to 25 per cent comes from within India. We have created a strong ecosystem of supply base and as a result, India has now become a sourcing point and our target is to increase sourcing five times over the next three years. We can proudly point that while the general trend is to import from China, across sectors, we are exporting to China.

India is one of the most important markets for Danfoss and this was reinforced in 2012 with the 100-million-dollar investment for the manufacturing, R&D and administrative facility in Chennai (Oragadam) which when inaugurated in November 2014 was perhaps the biggest milestone for Danfoss India till date. In line with our vision on energy efficiency and our own climate strategy, the plant also includes a solar power plant which generates 1MW of electricity, which is currently taking care of up to 15 % of

electricity requirements of the campus. Since our entry into the market, over the last 2 decades we have worked closely at the grassroot level and have enabled and enhanced profit earnings of farmers in the field of dairy, agriculture and horticulture by means of energy efficient technologies especially in the area of cold chain.

The Government has plans of setting up 100 new cold chain projects with investments of Rs 12,000 crore to Rs 13,000 crore.

So, what kind of opportunities do you foresee for Danfoss in India?

More than 400 million tons of perishables is lost every year. But India, as the rest of the world, also loses 100% of the food produced that it cannot handle. India in its quest to become the "World's growth engine" is looking for best practices, improved capabilities and technology transition around the globe. Danfoss has the capability and the solutions required to cater to this. "India has a need for having the right and most efficient infrastructure, and I believe the cold chain can become a gamechanger for the farmers in the future. With these investments into cold chain we expect an increase in storage and transportation demand for meat, milk, dairy products, horticulture, supermarkets selling processed foods and the need to meet food safety standards. Also, at the farm-end, farmers realisation that they get much better prices for their products when they invest in cold chain storage. Many farmers can come together and invest in such storage solutions. Danfoss, a global evangelist for energy conservation in the food sector offers a range of automated customisable solutions aimed at energy efficiency for the entire cold chain network spanning from farm to fork. This makes the cold chain sector a more viable investment destination in the eyes of investors and also enables cold room owners to earn better opex margins.

Energy cost is the largest operating cost for operating cold storage-upto 40-60 per cent of operating cost. With electricity costs going up, people understand the value of saving energy costs and our

products help save energy by up to 20 per cent. Ninety-nine per cent of our customers who have bought a product from us want a second one.

What are the trends in Indian cold chain segment? What is the penetration level of temperature controlled cold storage in India?

Cold chains are not only about preserving produce but to connect the grower with the market that will help in increasing production. About 40 per cent of the food in supply chain is wasted due to lack of infrastructure and cold storages. According to a report by the Federation of Cold Storage Associations of India, the cold storage industry annually grows by 12-15 per cent in bulk storage capacity.

The cold chain system integrates consumption with production, hence, assessing both supply and demand for any product (passing through the cold-chain system) is important for estimating the requirements of cold-chain infrastructure. Cold Storage (Bulk) and Cold Storage (Hub) numbers may vary depending upon the average static holding size of each unit. It is to mention that actual size and capacities will vary depending on business model and market dynamics. In case of bulk cold stores, though designed for holding a single crop for one cycle a year, enterprising operators can reoccupy vacated space with other goods by redesigning for multi commodity and this is observed to be in low volume. Ripening units, as with Cold Hubs can vary holding times to buffer last mile demand.

Ready to Cook (RTC) and Ready to Eat (RTE) segments of food industry are fastest growing segments due to rising demand from Modern Retail (MR) and Quick Service Restaurants (QSR). These products require specialised equipment at factory-gate like blast freezing lines and IQF processing lines. In order to assess the cold-chain requirement for these in a realistic manner, district-wise number of units and their operational capacity together with the captive infrastructure created by various private industries in the country will be required.

What role can organized retailers play in building cold chains in India?

The cold chain sector although being fragmented has a huge potential for retail to grow. India has about 6,300 cold storage facility with the capacity of 30.11 million metric tonnes, which are only able to store about 11 percent of the country's total perishable produce. About 60 percent of this capacity is spread across states of UP, West Bengal, Gujarat and Punjab. But still situation is severe in the south of the country where the cold hubs are not as per the requirements and the climate is hotter and far more humid. Retailers can tap this opportunity and set up facilities in south. It is true that setting up cold chain involves high cost and higher infrastructure cost for operations, but given the expected growth in grocery retail to \$ 847.9 billion by 2020 from \$ 500 billion in 2012, there are some changes expected by the industry as a whole to ensure the significant areas of handling food collection, storage and transportation be more cost effective for retailers.

What are the stumbling blocks faced during setting up of cold chain logistics infrastructure? How do you overcome these challenges?

There is a lot of potential for the cold storage industry in our country which is still untapped. Due to the lack of infrastructure and supply chain efficiency the sector has seen a setback. Primarily, we need to work on providing proper and adequate infrastructure for food storage, processing and cold chain logistics. The government must take measures to provide adequate facilities that streamlines the process for a better output. Also, the technical standards followed in India are mostly unsuitable for Indian conditions, which results in lower performance of standard refrigerated systems.

There is a need to set standards and protocols in construction and operation of facilities. Secondly, there must be proper training that has to be provided to the laborers in the sector. There cannot be any compromise on the quality of the product, hence training programs play a major role.



For corporates, the high level of initial capital required to construct a cold chain unit continues to be the biggest challenge. But if the government pitches in with a clear plan and promotes more PPP initiatives in this field, we could see a momentum growth in the cold chain industry in India.

India is one of the largest producers of agricultural products and one of the global leaders in the pharmaceutical sector. Yet, it is known to have fledging cold chain, which results in supply chain losses of food and other resources. So, what are the solutions offered by Danfoss in order to stop these losses?

At least 25 per cent of the vaccines go waste even before reaching the doctors and patients while many lose their efficacy by the time they are administered due to lack of quality supply chain and logistics management system. This is posing a major challenge for the government as well as public health agencies working to expand the immunisation coverage, mainly, in the hinterland where supply chain logistics and infrastructure are in poor shape.

When you look at it from a technology

perspective our solutions for cold chain are available from -30 deg to + 20 deg and these can be used across spectrum with higher efficiency.

The Government of India launched 'Make in India' campaign in order to make the country manufacturing hub. So, what are the products that the company manufacturing in the country? Do you have any expansion plans?

We kick started our own 'Make in India' initiative two years ago in Danfoss. There were two key aspects that triggered this initiative – the tremendous potential for growth and thrust given by the government for the manufacturing sector.

Danfoss has a three pronged approach to make in India: First is to make in India for the Indian market, second is to make in India for the rest of the world, and third is to make components in India for application in global innovations. It thrives to make India the manufacturing hub for energy efficient solutions.

In India, Danfoss is constantly engaged in improving skilling across the refrigeration and air-conditioning sectors in India as there is a huge skill gap that exists here. Aiming to improve the skilling scenario in the country, Danfoss has set up

refrigeration and air-conditioning and advanced drives laboratories across various colleges in India including YMCA Faridabad, VIT College, College of Engineering Pune, etc. to give hands on approach to future talent.

Having built a strong ecosystem of suppliers, we are evaluating more products to be made in India. Increased demand for processed and frozen food has edged us on to Make in India for India and for the world. Key market trends such as rising export demand for processed and frozen food has edged us on to Make in India for India and for the world.

Cold storages are dependent on steady supply of power. Apart from this, fuel constitutes a major portion of operating costs. So, what are measures taken by the company to make them energy efficient and superior?

Cooling or cold chain infrastructure can account for close to one third of the total energy consumed running into heavy operational expenses. This expense, when added to the installation cost of corrective technology is often the reason why the quality of optimal preservation gets compromised. However, with the right technology, engineered by Danfoss can save up to 33 % on the energy bill without compromising on food safety. With the wide range of control products from Danfoss, one can achieve the required flexibility to configure the most reliable and energy efficient solutions for every food store in your chain- A win-win situation for both the retailer and the consumer who only gets food in finest quality.

From helping banana farmers in Theni triple their profits to enabling grape growers in Nashik make world class produce by adopting the right cooling technologies, today as a trusted knowledge partner to state governments and institutions working relentlessly towards addressing the issue on food safety, Danfoss India for the last two decades has been working closely with policy makers and stakeholders in the cold chain at the centre and in several states towards

ensuring that we develop a sustainable cold chain infrastructure.

What are the technological innovations that you would like to bring in your company to make the operations of cold chain logistics more efficient?

As indicated earlier we have made a 100-million-dollar investment in India of which a significant part is in R&D in the last 30 months since inaugurating the plant we have made significant progress especially in reverse engineering where global products have been engineered for better application in India.

Energy efficiency is at the core of our energy system development and one must understand that it has a direct impact on our GDP. Psychrometric (PSR) lab at our campus, which tests products for energy efficiency standards, has the potential to redefine manufacturing and designing of energy efficient products in India, thereby, meeting global standards of quality and reliability.

What will be the impact of GST on Danfoss' cold chain business in India?

GST will be one of the significant moves for cold storage logistics and the transport sector. It will certainly enable cold storage investments. I'll tell you why. If you take any infrastructure, we have a mindset in India that the internal rate of return (IRR) should be 26-27 per cent. That mindset is prevalent because of GST not being there. Once GST is a law, people will be able to see that they can settle down for an 18-19 per cent IRR because they have a strong cash flow coming in. The cash is also getting locked in to the system, right? The cash will get released and investors will feel far more confident enough to put in their money.

The other side of the coin is that, let's say, you are shipping bananas from Tamil Nadu to Delhi. The whole logistics chain (intermediaries, aggregators, etc.) will now have one way of doing things, so you'll have far lesser impact of cost escalation. In my view, GST would also have a significant impact on inflation;

because it will be a derived spin off effectively that you will see moderating prices. People investing in cold storages, will of course benefit because as I mentioned earlier, one needs about 39 different approvals. Even to keep your record books, you need to file your taxation. It will get much more simplified in my view.

What are the growth drivers for Cold Chain Logistics? Which sector does generate the maximum demand?

With the advent of technology, the world is globally connected. Increasing interest in healthy food, are pushing cold chains for globalization. Globally, the focus now has shifted from increasing the production to better storage and transportation of food produce. Cold Chain now has become an integral part of the supply chain management for the storage and transportation of temperature sensitive goods. Utilization of cold chain logistics includes both the cold storages as well as refrigerated transportation and is used to increase the shelf life of food produce.

Ready to Cook (RTC) and Ready to Eat (RTE) segments of food industry are fastest growing segments due to rising demand from Modern Retail (MR) and Quick Service Restaurants (QSR).

What is your outlook for the sector for the fiscal 2017-18?

2016 was a landmark year that saw the Central Government has made some bold moves to better ensure transparent governance. We can reflect and laud on the milestones, in addition GST and demonetization took the nation by as much surprise and acceptance, setting the tone for a promising 2017. It should, therefore, be the year of reviving productivity, improving quality of production, conserving the food, building capacity and creating local and international market that can open avenues for the farmer community to double their income by gaining improved access to consumers through improved infrastructure.

The single gravest issue that needs quick redressal is that of the dwindling profit

margins. With cash, the primary mode of transaction in the agricultural sector, having taken a hit with demonetization, farmers although the country achieved remarkable economic growth, growth in productivity has stagnated over time affecting the farmers. To revive this, the government should reduce excessive reliance on exports to developed economies by shifting to a development approach. In order to boost agricultural productivity steps must be taken to empower farmers through knowledge transfer on best irrigation practices, post-harvest food conservation measures across farm to fork and enable them with technology that can raise the bar in creating produce of global export quality. This will help curtail food losses; improve profitability and control inflation.

What are your expectations for the sector in order to bring the sector on growth trajectory?

Government should adopt, assess and implement programs from other sectors that has proved to be a best practice in optimizing utilization and minimizing waste. Government should consider linking the production centres to the consumption centres through cold chain grids. These if synchronized between producers and suppliers can connect key production areas with centralized distribution channels that ensure last mile delivery of the produce in the desired quality – For eg. There are a few flowers which can be harvested four times a day and have a demand both locally, mid distance markets, long distance markets and export markets.

By knowing the markets and timing the harvest the producers can meet the demand and have a higher share of wallet with reduced loss. This would, however, need an efficient cold chain network criss crossing the country. These networks for eg will connect Theni and Chennai in Tamil Nadu, Cochin to Coimbatore and Chennai to Bangalore etc. This network of well-equipped efficient cold storage facilities can serve as a warehouse for movement of perishables. ■

Scroll Compressors

Many residential central heat pump and air conditioning systems and a few automotive air conditioning systems employ a scroll compressor instead of the more traditional rotary, reciprocating, and wobble-plate compressors...



A scroll compressor (also called spiral compressor, scroll pump and scroll vacuum pump) is a device for compressing air or refrigerant. It is used in air conditioning equipment, as an automobile supercharger (where it is known as a scroll-type supercharger) and as a vacuum pump.

A scroll compressor operating in reverse is known as a scroll expander, and can be used to generate mechanical work from the expansion of a fluid, compressed air or gas. Many residential central heat pump and air conditioning systems and a few automotive air conditioning systems employ a scroll compressor instead of the more traditional rotary, reciprocating, and

wobble-plate compressors.

Design

A scroll compressor uses two interleaving scrolls to pump, compress or pressurize fluids such as liquids and gases. The vane geometry may be involute, Archimedean spiral, or hybrid curves.

Often, one of the scrolls is fixed, while the other orbits eccentrically without rotating, thereby, trapping and pumping or compressing pockets of fluid between the scrolls.

Another method for producing the compression motion is co-rotating the scrolls, in synchronous motion, but with offset centers of rotation. The relative motion is the same as if one were orbiting.

Efficiency

The isentropic efficiency of scroll compressors is slightly higher than that of a typical reciprocating compressor when the compressor is designed to operate near one selected rating point. The scroll compressors are more efficient in this case because they do not have a dynamic discharge valve that introduces additional throttling losses. However, the efficiency of a scroll compressor that does not have a

discharge valve begins to decrease as compared to the reciprocating compressor at higher pressure ratio operation. This is a result of under-compression losses that occur at high pressure ratio operation of the positive displacement compressors that do not have a dynamic discharge valve.

The scroll compression process is nearly 100% volumetrically efficient in pumping the trapped fluid. By comparison, reciprocating compressors leave a small amount of compressed gas in the cylinder, because it is not practical for the piston to touch the head or valve plate. The reduction in capacity (i.e. volumetric efficiency) depends on the suction and discharge pressures with greater reductions occurring at higher ratios of discharge to suction pressures.

Reliability

Scroll compressors have fewer moving parts than reciprocating compressors which, theoretically, should improve reliability. According to Emerson Climate Technologies, manufacturer of Copeland scroll compressors, scroll compressors have 70 percent fewer moving parts than conventional reciprocating compressors.

In 2006 a major manufacturer of food service equipment, Stoelting, chose to change the design of one of their soft serve ice cream machines from reciprocating to scroll compressor. They found through testing that the scroll compressor design delivered better reliability and energy efficiency in operation.

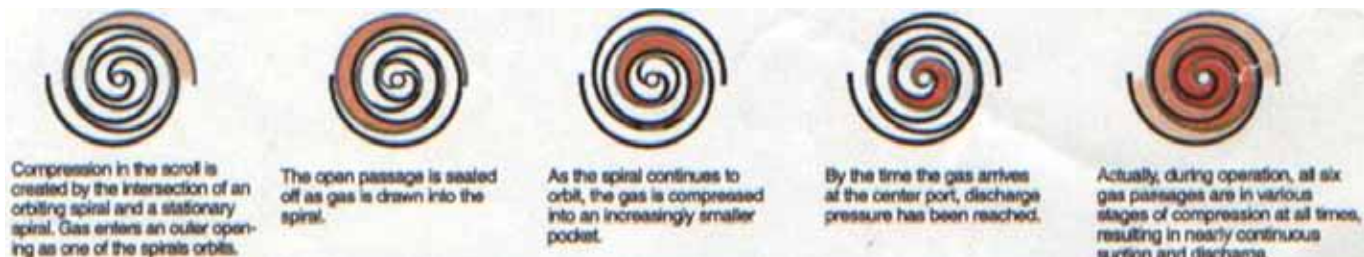


Figure 1. Principle of Scroll Compressor

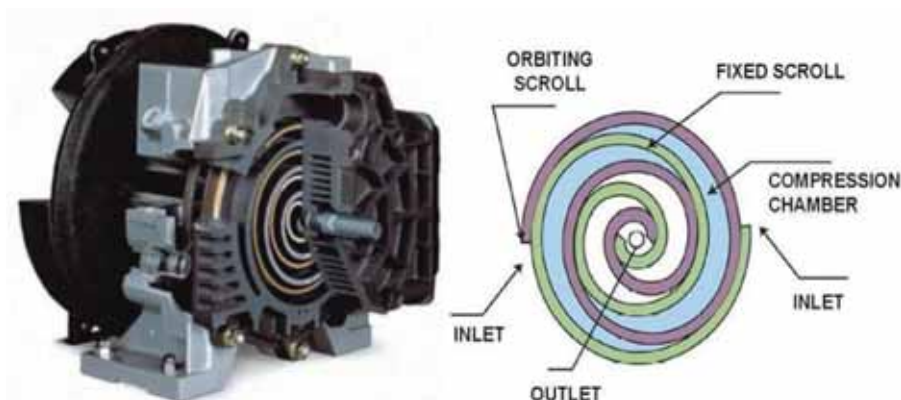


Figure 2. Horizontal Scroll Compressor

Size

Scroll compressors tend to be very compact and smooth running and so do not require spring suspension. This allows them to have very small shell enclosures which reduces overall cost but also results in smaller free volume. This is a weakness in terms of liquid handling. Their corresponding strength is in the lack of suction valves which moves the most probable point of failure to the drive system which may be made somewhat stronger. The small size and quiet operation of a scroll compressor allow for the unit to be built into high power density computers, like IBM mainframes. Scroll compressors also simplify the piping design, since they require no external connection for the primary coolant.

Partial Loading - Limitations

Until recently, a powered scroll compressor could only operate at full capacity. In order to achieve part-loads, engineers would bypass refrigerant from

intermediate compression pocket back to suction, vary motor speed, or provide multiple compressors and stage them on and off in sequence. Each of these methods has drawbacks:

- Bypass short-circuits the normal refrigeration cycle and allows some of the partially compressed gas to return to the compressor suction without doing any useful work. This practice reduces overall system efficiency.
- A two-speed motor requires more electrical connections and switching, adding cost, and may have to stop to switch.
- A variable speed motor requires an additional device to supply electrical

power throughout the desired frequency range. Also variable frequency drive associated with variable speed compressor has its own electrical losses, and is a source of additional significant cost and often is an additional reliability concern.

- Compressor cycling requires more compressors and can be costly. In addition, some compressors in the system may have to be very small in order to control process temperature accurately.

Applications

About 30% of Reefer Containers use Scroll Compressors mainly for their easy servability. A scroll compressor used for Reefer Container weighs about 44 kgs compared to 125 kgs of a semi-hermetic compressor. This is particularly useful when servicing the Reefer Containers which are 2 or 3 tiers above the main deck.



Figure 4. Internal Parts of Carrier Scroll Compressor used in Refrigerated Containers

Limitations of Scroll Compressors

1. Since they are sealed units, field servicing of Scroll Compressors is not possible. Only replacement is recommended. The defective scroll compressors are landed with the manufacturers for reconditioning.
2. Scroll compressors are unidirectional compressors. Running in opposite direction may cause mechanical lockage, high current draw and burn out of the drive motors. Hence an additional phase reversal protective circuit is incorporated in the starting circuits. The incoming phase sequence is detected and corrected before going to the compressor. ■

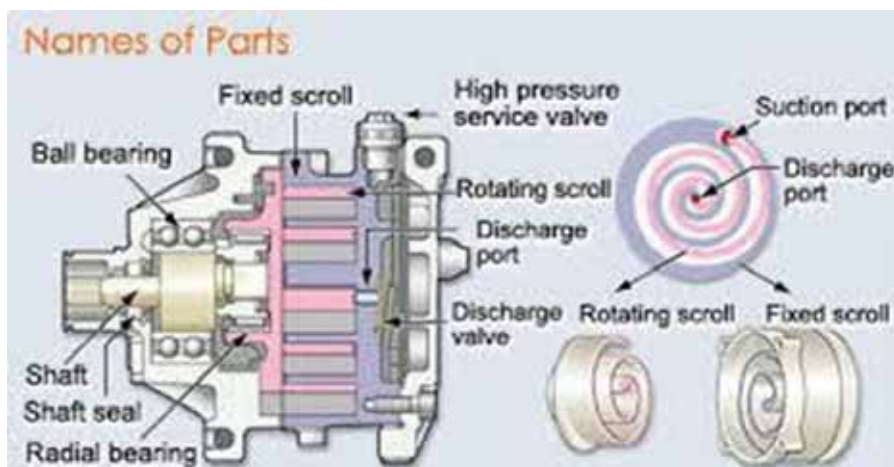


Figure 3. Components of Scroll Compressor

Cadet Mayank
Graduate Marine Engg
Training, Anglo Eastern
Maritime Academy



Energy Conservation in Clean Room

Clean rooms find applications in many industries and a detailed system study and analysis will lead to identifying all potential areas for energy conservation. Many such opportunities are described in this article...

Clean rooms have controlled environment, where low level of pollutants such as dust, airborne microbes, aerosol particles and chemical vapours are permitted to remain. The controlled level of contamination is specified by the number of particles per cubic meter at a specified particle size. Clean rooms find applications where small particles can adversely affect the manufacturing process. They vary in size and complexity and are used extensively in industries such as research organisations, semiconductor manufacturing, pharmaceuticals, medical, aerospace, optics, military, etc..

The key component of a clean room is the High Efficiency Particulate Air (HEPA) filter, used to trap particles that are 0.3 micron and larger in size. All of the air delivered to a clean room passes through HEPA filters, and in some cases where stringent cleanliness performance is necessary, Ultra Low Particulate Air (ULPA) filters are used. Persons working in cleanrooms are trained in controlling the contamination. They enter and exit the clean room through airlocks, air showers, etc. and they wear special clothing designed to trap contaminants, normally generated by human body. In clean rooms, technical arrangement is made to reduce

the particulate contamination and also to control air parameters such as air temperature, velocity, humidity and pressure.

Air Conditioning

Schematic diagram of a typical air conditioning (AC) system of a clean room is shown in figure 1. Chilled water from a centralised AC plant is used to chill the air and in turn to condense the moisture present. Pan humidifier and electrical heaters are used to maintain the required relative humidity (RH). Fresh ambient air is also chilled and added to meet the ventilation air requirement and the excess air gets out through small openings in the clean room. The air conditioned space is provided with false ceiling and chilled air enters through supply grille and there is separate duct for return air. The temperature of room air is controlled by the actuation of modulating valve to regulate the chilled water flow. Whenever the required conditions (say 23 ± 1 OC temperature



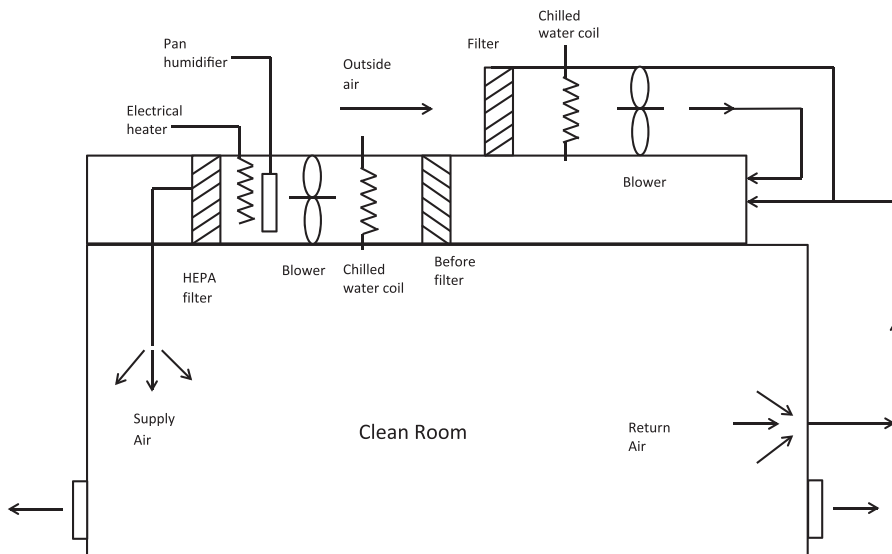


Figure 1: Schematic of a typical clean room.

and 55 ± 5 % RH) are achieved, the modulating valve will close and heaters will become OFF. Whenever the modulated valve is actuated (to reduce the chilled water flow), the chilled water is by-passed to the return line. Proper selection of blower will ensure that required air velocity is maintained inside the clean room for air circulation. Timely maintenance of air filters will ensure that strict dust level is maintained.

Energy Conservation Opportunities

The energy conservation opportunities in clean room applications are given below:

- The return air from clean room is hot and supply air is cold. Instead of using electrical heaters for RH control of chilled supply air, heat in return air can be transferred to supply air through a heat recovery wheel as shown in figure 2 and that much load on chilled water will also get reduced. The saving in energy will be enormous.
- Significant amount of power is being lost in transmission of power between motor and blowers. Now-a-days direct driven motor blowers are available with advanced controls for optimising the cooling load. Such systems need to be used.
- Conventionally, the air handling unit

(AHU) filters are cleaned at some interval and some of the filters and chilled water coil fins are choked. It is suggested to have 20-25 numbers of air filter panels of AHUs as stand by. The choked filters need to be replaced (once in 2-3 weeks) with stand by ones. After washing, the clean filters may be used on next AHU and the process may be continued. This will improve the cooling performance of AHUs and avoid choking of chilled water coils and to increase the life of AHUs.

- Removing the air filters, the chilled water coil fins (in front of the blower) need to be inspected. The dirt between the fins needs to be cleaned with either compressed air or water jet from inside the AHU (opposite to normal air flow) so that dust and gel like substance is removed. It may be ensured that torn / damaged air filters are not used. If filters are cleaned in time, these things do not happen and performance & life of AHU is increased.
- Unnecessary heat generating loads (like UPS, photocopy machine, etc.) inside clean room needs to be shifted out to non-AC rooms.
- The efficiency of blower needs to be estimated based on the air flow rate, pressure developed and power drawn and if the efficiency is below 40 %, it needs to be replaced with high efficiency one.
- Replacement of three way valve of modulating motor with two way valve will lead to energy saving if variable frequency drive (VFD) is used with chilled water pump.

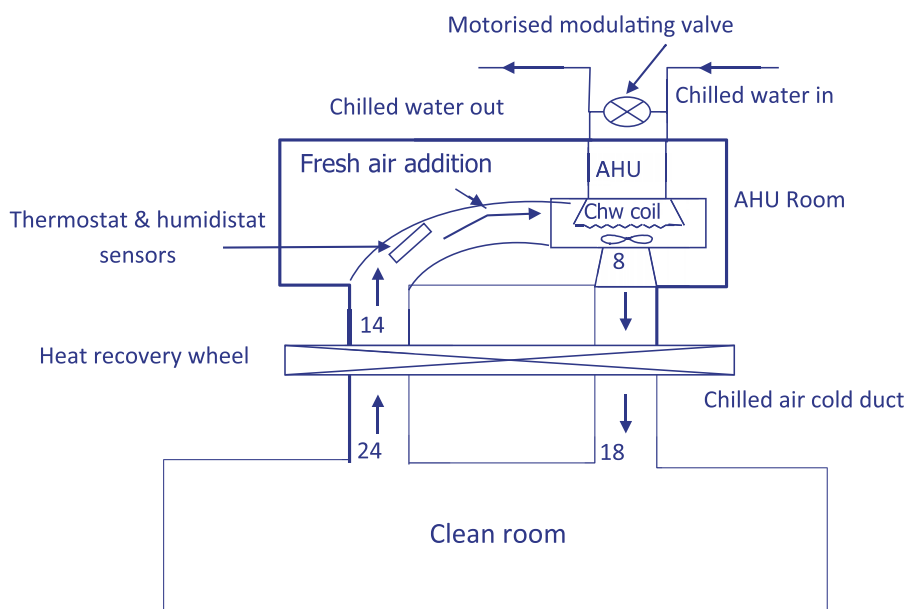


Figure 2: Schematic of typical heat recovery based RH control system

Conclusions

Clean rooms find applications in many Industries and a detailed system study and analysis will lead to identifying all potential areas for energy conservation. Many such opportunities are described in this article. ■

S Jothibas
Joint Director
Central Power Research
Institute, Bangalore



Dangers of Cold Storages

Cold storage facilities carry all the same potential dangers as a standard warehouse, as well as a few special risks and fire hazards that have to be dealt with. Risk assessment shows the kind of approach a cold storage warehousing might take. Use it as a guide to think through some of the hazards in place and the steps needed to take to control the risks towards protecting people...

Cold storage is basically a term used for refrigerated or frozen storage facilities. Cold stores can be used in rooms, homes, supermarkets, warehouses for a host of applications including storing foodstuffs,

pharmaceuticals and medicines, ambient products, chilled produce and frozen products. Cold storage could be something as small as a walk-in cooler or freezer or big warehouse. It could also be mobile such as a reefer trailer (refrigerated semi-

trailer) or cargo container to go on ships. Cold storage usually refers to freezing temperatures or below but can also apply to cooler temperatures. The flexibility of bespoke cold storage can come in particularly handy at seasonal peak times, when the need for extra storage arises or if a facility needs to move, the whole system can easily be relocated. The flexibility can accommodate site expansion, increase in production and any changes in legislation. To explain what makes up a cold room and how it operates, a cold room/store, as the name implies, is a distinct kind of room where very low temperature is maintained at all times. This special type of room is able to keep its temperature with the help of precision instruments and other similar



machines. With the advanced technology that we have today, it is not surprising that cold room facilities are continuously built and improved upon. They not only have a great impact on our daily lives but they also play a big role in the unstable game of supply and demand, in terms of perishable goods. Although there are other industries that make use of cold rooms, the food industry is the first on the list of sectors in need of these special facilities. These cold storage facilities are commonly built to store perishable goods for a period of time. Due to the increasing demand in food supply, the production of perishable goods such as fruit and vegetables continues to rise. In order to preserve these types of goods, they need to be placed in cold storage facilities to make sure that they do not spoil. Cold rooms are very important because they help to prolong the shelf life of fresh goods. They are also effective in reducing the amount of waste and in lengthening the timeframe for marketing these foods.

Cold Storage Capacity Building

Use of cold storage facilities called cold storage warehousing is growing very fast with a rising concern of people about controlled cost, availability on demand, comfort, freshness of food items etc. Cold stores are carefully designed to meet the client's needs and purposes. From project management to the final construction of the facility, every little detail is taken care of until the whole facility is completed. A project designed for the food and drink industry includes the following services: food manufacturing facilities, chiller and freezer cold stores, drainage installations, hygienic floor finishes, service and preventative maintenance and many others. Cold storage humidification



systems afford the people in charge of food transport the ability to control the temperature, moisture, and air quality surrounding the food. The appropriate temperatures and humidification directly affects food safety. Commercial humidification used during food transport and in grocery store storage facilities, ensures that food items reach the shelves as close to ripe, fresh, and healthy as possible. If the food we eat is of a high quality, then our overall health can follow suit. India has around 6,300 cold storage facilities, with a capacity of 30.11 million tonnes. However, some 75-80 per cent of these refrigerated warehouses are suitable only to store potatoes, a commodity that produces only 20 per cent of agricultural revenue. Therefore, India needs expansion of cold storage infrastructure in an affordable, reliable and sustainable way to increase the contribution of agriculture to the economy. India's investment in cold

chain is projected to be \$15 billion over the next five years. The organization found that only 10-11 per cent of the fruits and vegetables produced in India use cold storage. Storage capacity needs to be increased by 40 per cent to avoid wastage.

Dangers In Cold Storage Facilities

There are a number of special dangers and problems associated with cold storage facilities and cold storage maintenance. Cold storage facilities carry all the same potential dangers as a standard warehouse, as well as a few special risks and fire hazards that have to be dealt with. Risk assessment shows the kind of approach a cold storage warehousing might take. Use it as a guide to think through some of the hazards in place and the steps needed to take to control the risks towards protecting people. Following type of dangers can be encountered:



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Insulated Metal Panels: Effectively sustaining adequate temperature ranges in refrigerated warehouses presents itself as an obstacle that is frequently cleared by installing insulation in the ceilings and walls of the facility. However, it's important to avoid using unprotected spray-on foam padding while performing cold storage maintenance in order to lessen the chances of fire spreading quickly across the building's ceilings and walls. It's important to choose these metal panels made with non-flammable cores (like those that are comprised of mineral wool), or those that have been approved according to approval standards.

Ammonia: Very frequently, ammonia is the preferred coolant in refrigerated storage facilities. Anhydrous ammonia, which is a highly combustible gas, has the ability to cause catastrophic fires and booms. Standard ammonia is considered a dangerous substance as well, and as a result its use must adhere to safety guidelines for cooling systems.

Moisture: In addition to temperatures within cold storage units and warehouses, moisture levels are of considerable importance. When relative humidity levels are too dry, goods dehydrate and shrink. When condensation levels are too high, electronics may experience problems, goods deteriorate and products may experience mold, bacterial or insect contamination that may pose health risks to workers and consumers. Electronics designed specifically for cold storage areas experience difficulties to workers when exposed to humidity and condensation like: not to be productive

and failure of electronic devices,

Fire risks: It may sound illogical given the extremely cold conditions, but cold storage facilities actually carry a significant fire risk. There are many contributing factors to this, from chemicals to air composition to simply the storage of

flammable goods and packaging. Minimizing this risk is obviously crucial for anyone operating such a facility.

Safety Measures

Because cold storage areas are generally confined type of spaces so there is always a need to get training and become familiar with the safety features at a cold storage along with some pre-requisite safety measures at cold storages.

- For escape in an emergency, cold storage rooms should have at least one door that opens from the inside
- Lighting must be supplied through a constantly burning bulb or a light with an illuminated switch located inside the cold room
- Non-slip flooring mats protect workers in wet areas
- If anti-freeze doors are not installed in at the cold storage workplace, ensure that a firefighter's axe is stored in the room.
- Items in cold storage are often valuable and require security.
- Doors at the worksite must have inside and outside locking mechanism.
- Other options include posting warning signage on the door and providing audible and visible signal systems inside the room that are tested daily.
- Ensure that chemicals in cold storage are stocked properly and with compatible materials.
- Note that forklifts and combustion equipment can cause fumes to build up in enclosed spaces – use only with proper ventilation.

Precautions

While working in cold storages one must be aware of the hazards that might be involved with cold storage viz., cold stress, slips and trips, confined space, gas-leakages, fire hazards, chemical storage, and ergonomics.

- Dress in warm, layered clothing for proper insulation to maintain body temperature to prevent cold stress
- For extra warmth, wear a warm cap with ear flaps
- Fingers, hands, toes, and feet are susceptible to frostbite with long term exposure to cold; protect them with insulated, moisture-proof gloves and boots
- Water and ice are common in cold storage and pose slip and trip hazards so ensure that boots have no-slip soles
- Take caution with dry ice and liquid nitrogen which can pose an asphyxiation hazard by displacing oxygen.
- Keep cold storage areas safe by protecting yourself from all type of risks and also watch out for your co-workers and check cold storage areas periodically and at closing to ensure no one is trapped. Clean up spills and clutter for good housekeeping and to prevent slip and trip hazards.

Finally, use of cold storages is a well accepted reality, need and a challenge of present day living system. However, the dangers associated with the cold storages and their use cannot be eliminated. Therefore, with proper safety measures and required precautions, we can prevent the accidents, life loss and cost due to accidents while using cold storages. In the last, it can be said that it is easy to keep cold store safe, as long as we follow the safety measures and precautionary measures as listed above. ■

Dr. S. S. Verma
Department of Physics,
S.L.I.E.T., Longowal,
Distt. Sangrur - Punjab



Walmart's Initiatives for Reducing Greenhouse Gases

Through release of a sustainability toolkit, Walmart asks suppliers to reduce greenhouse gas emissions by one gigaton – the equivalent to taking more than 211 million passenger vehicles off of US roads for an entire year...



During Walmart's annual Milestone Summit, the company launched a sustainability platform inviting suppliers to join Walmart in committing to reduce greenhouse gas emissions resulting from their operations and supply chains. Dubbed Project Gigaton, this initiative will provide an emissions reduction toolkit to a broad network of suppliers seeking to eliminate one gigaton of emissions, focusing on areas such as manufacturing, materials and use of products by 2030. That's the equivalent to taking more than 211 million passenger vehicles off of U.S. roads and highways for a year.

Walmart is the first retailer with a verified science-based target emissions-reduction plan. The company aims to reduce its absolute Scope 1 and 2 emissions by 18 percent by 2025. The retailer will also work to reduce CO₂e, or carbon dioxide equivalent, emissions from upstream and downstream Scope 3 sources by one billion tons (a gigaton) between 2015 and 2030.

Project Gigaton is part of a series of Walmart sustainability initiatives focused on addressing social and environmental issues in ways that help communities while also strengthening business. For example, by investing in solar energy, Walmart has helped to support jobs for American solar companies. Walmart is now one of America's leading commercial solar and on-site renewable energy users and gets about 25 percent of its global energy from renewable sources. "We are proud of the improvements we've

made in reducing our own emissions, but we aim to do more. That's why we're working with our suppliers and others on Project Gigaton," said Kathleen McLaughlin, Senior Vice President and Chief Sustainability Officer for Walmart.

Walmart has identified energy, agriculture, waste, packaging, deforestation, and product use and design as the goal areas in which to focus their Scope 3 climate efforts. Participating suppliers are encouraged to focus their commitment in one or more of these goal areas. To help suppliers make commitments to emission reduction, or to establish emission reduction projects, Walmart collaborated with NGOs like World Wildlife Fund and Environmental Defense Fund, and additional like-minded organizations to create an emissions reduction toolkit. In this toolkit, Walmart highlights the business case for why suppliers should consider signing on to Project Gigaton.

"Supply chains are the new frontier of sustainability. The journey products take from source to shelf will collectively shape our planet's future," said Carter Roberts, President and CEO, World Wildlife Fund. "Project Gigaton is a testament to the transformative impact that leaders of industry can have on our greatest common challenges. As more companies follow in the footsteps of Walmart and their suppliers, we can achieve the critical mass needed to address climate change. Today's commitment represents an important step toward a safer and more prosperous future."

"A challenge like Project Gigaton will catalyze leadership and innovative solutions around the globe," said Fred Krupp, President of Environmental Defense Fund (EDF). "Forward-looking companies like Walmart, and the suppliers that will join them, know that our economy and our planet can—and must—thrive together. Consumers deserve both, and these businesses are leading the way. EDF looks forward to helping them along this journey."

"Through the years, we've seen that integrating sustainable practices into our operations improves business performance, spurs technological innovation, inspires brand loyalty, and boosts employee engagement," said Laura Phillips, senior vice president, Sustainability for Walmart. "Our suppliers recognize the opportunity to realize those same benefits in their businesses. By working together on such an ambitious goal, we can accelerate progress within our respective companies and deep in our shared supply chains."

Clean Indoor Environment

This article provides a holistic alternative of traditional cooling system through natural ventilation and clean air circulation in Indian scenario. Combined wind and stack ventilation with filtering incoming air may be an eco-friendly alternative...

Natural ventilation is the process of supplying and removing air through an indoor space by natural means, meaning without the use of a fan or other mechanical system. It uses outdoor air flow caused by pressure differences between the building and its surrounding to provide ventilation and space cooling. The use of natural ventilation is definitely

an advantage with the raising concerns regarding the cost and environmental impact of energy use. Not only does natural ventilation provide ventilation (outdoor air) to ensure safe healthy and comfortable conditions for building occupants without the use of fans, it also provides free cooling without the use of mechanical systems. When carefully

designed, natural ventilation can reduce building construction costs and operation costs and reduce the energy consumption for air-conditioning and circulating fans. An additional bonus is that no longer will any noisy fan be of your concern.

Natural ventilation is very common in India. Even in the Mughal period when gross domestic product of India was one-fourth of the world economy, natural ventilations were widely used. It can be well understood from the design of Hawa Mahals where corridors are set in such a way to allow a high rate of air infiltration inside the building and ensure passive cooling in the same. However, with the advancement of technology, cooling systems were confined to refrigeration and



In the design of Hawa Mahals, the corridors are set in such a way to allow a high rate of air infiltration inside the building and ensure passive cooling in the same.

air-conditioning. The underlying principal in these cooling systems is the Clausius statement of 2nd law of thermodynamics. According to the law, power input is required to run these cooling systems since in these systems heat is transferred from low temperature to high temperature body. For the sake of convenience, a heat engine can be coupled with refrigeration system for power input. In that heat engine heat is mostly supplied by burning fossil fuel which causes disturbance to the environmental harmony. Not only this, it is very difficult to find eco-friendly refrigerant. Commonly used refrigerants are being phased out as they are highly responsible for global warming (greenhouse gas) and ozone layer depletion. Considering these problems in active cooling, passive cooling through natural ventilation of wind is highly required to maintain harmony with nature.

There are basically two types of natural ventilation that can be employed in a building: wind driven ventilation and stack ventilation. Both of which are caused by naturally occurring pressure differences. However, the pressure difference that causes wind driven ventilation uses the natural forces of the wind whereas stack ventilation is caused by pressures generated by buoyancy as a result in the differences in temperature and humidity. Hence, there are different strategies in the optimization of the two types of natural ventilation.

Stack Ventilation

Buoyancy ventilation can be induced by temperature (known as stack ventilation) or by humidity (known as cool tower). Most commonly used is the stack driven ventilation. For stack ventilation to work properly there must be a temperature difference. As the warm air (usually given off by the occupants and their computers), which is less dense, in the building rises, the cooler air is sucked from the openings below. Design considerations for stack ventilation are (i) inlets should supply air low in the room. Outlets should be located across the room and at high level, (ii) the vertical distance between the inlet and exhaust openings should take advantage of the stack effect, (iii) use skylights or

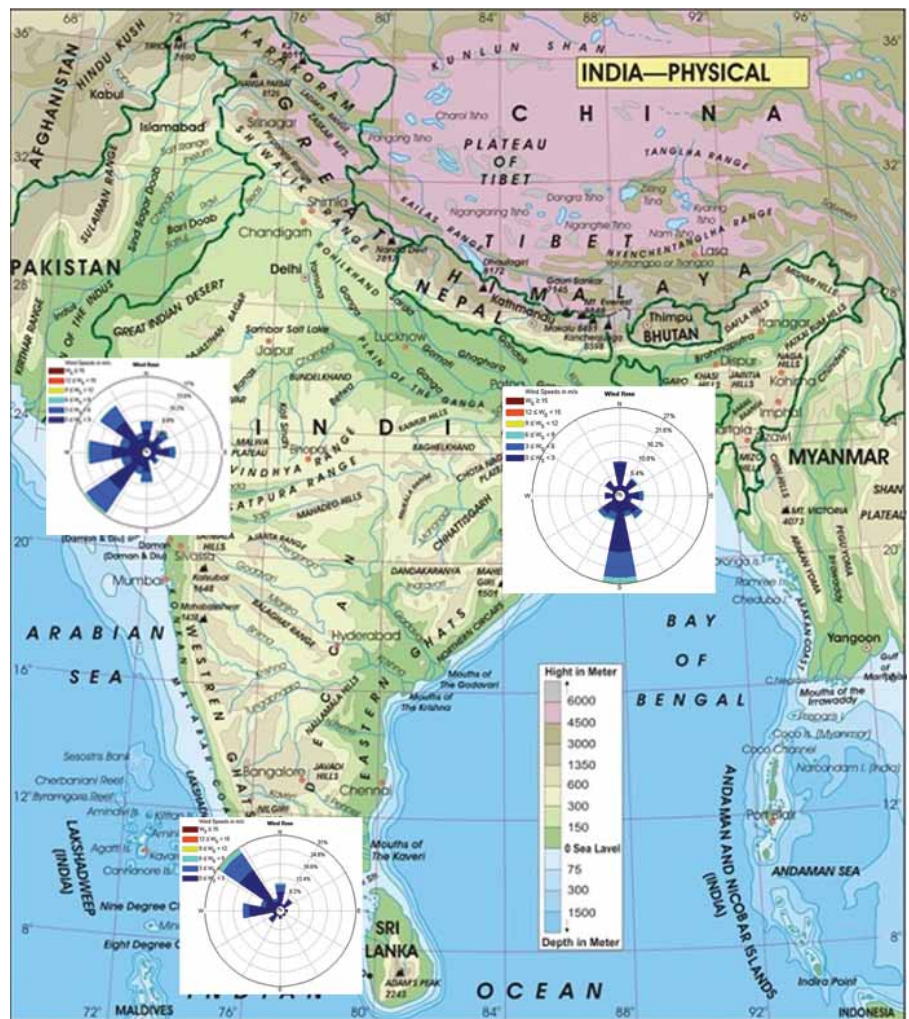


Figure 1: Map of India with three different wind roses in coastal regions

ridge vents and (iv) the function as fire exits of enclosed staircases should not be compromised if stack ventilation is incorporated into the design. With stack ventilation, it does not rely on the wind. On hot summer days with no wind, the naturally occurring stack effect can take place with relatively stable air flow. Moreover, because it does not rely on the pressure and direction of the wind, there is a greater control on locating the air intake. However, stack driven ventilation is limited to a lower magnitude than wind driven ventilation. It is also very dependent on the inside and outside temperature differences.

Wind Driven Ventilation

As naturally occurring wind blows across a building, the wind hits the windward wall causing a direct positive pressure. The wind moves around the building and leaves the leeward wall with a

negative pressure, also known as a sucking effect. If there are any openings on the windward and leeward walls of the building, fresh air will rush in the windward wall opening and exit the leeward wall opening to balance and relieve the pressures on the windward and leeward walls. Capturing the wind and bring ventilation to the building depend on the building shape, building orientation and location, building form and dimensions, window typologies and operations, types, shape and size of openings, construction methods and detailing, external elements, urban planning consideration, etc.

Wind Speed and Availability

India is a tropical subcontinent which has larger coastal regions. In these regions, wind flow is highly induced due to differential heating of land and water. In these coastal regions, lots of villages are

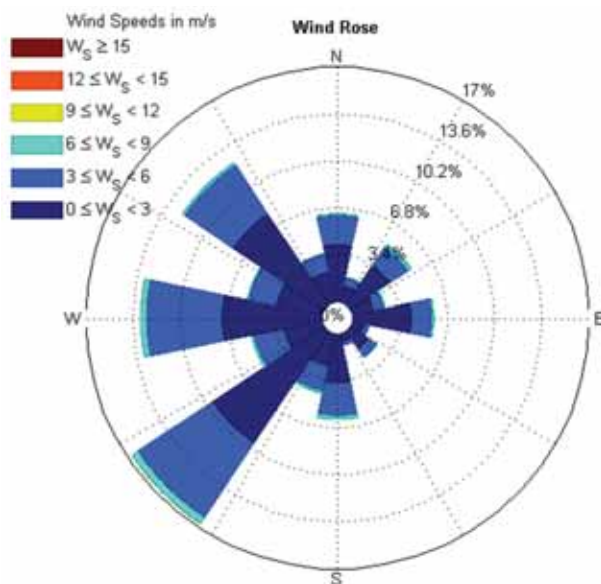


Figure 2: Wind rose of Ahmadabad

also situated especially in the states of Orissa, Andhra Pradesh, Tamil Nadu and Kerala. In these villages there are many hut like structures where natural ventilation can be provided by the proper setting of the window. Obviously, wind speed plays a major role in natural ventilation. From the view of human comfort wind speed should neither be very large nor very low. Best wind speed ranges for passive cooling is the wind speed for breeze which varies from 2-8 m/s. Now the question is the availability of this wind speed range in that particular location. Wind speed is highly location specific. Even in a particular location wind speed greatly varies in different months. To determine availability of a particular wind speed range, an availability factor can be defined which can be equated to the probability of occurrence of wind speed in the particular range for that location. The prerequisite of determining availability factor is the measurement of wind speed in each hour. India has a large network of meteorological stations controlled by Indian Meteorological Department (IMD) which measures hourly mean wind speed data in each of twenty-four hours of a day and 3 sec gust wind speed data. However, wind zone map of India is based on 3 sec gust wind speed data in which India is divided into six zones and basic wind speeds on the basis of peak gust wind speeds have been

determined which vary from 33 to 55 m/s. The map is very much useful for specification and codification of design wind load on structures under extreme wind conditions. However, for wind induced natural ventilation parent wind climate modeling is of greater importance. For this purpose it is required to understand the measurement and analysis of hourly mean wind speed data. Hourly mean wind speed is measured at a height of 10 m by dyne pressure

tube anemograph. It is measured in the last 10 minutes before the completion of the full hour and the last 10-min mean is considered as hourly mean wind speed. Though wind speed data is non-stationary, they can be converted into independent and identically distributed data (iid) by carrying out time series analysis and removing trend as well as white noise from the data. After converting wind speed data into random data, they can be modeled by a suitable probability distribution. It has been observed that wind speed probability density distributions, especially for the coastal regions, are highly skewed. Hence, normal distribution may not be an appropriate choice for wind speed data modeling. For this purpose, Weibull, Log Normal and Exponential distributions can be used. The availability factor can be determined by integrating probability density distribution within the appropriate wind speed range.

Wind Direction and Wind Rose

Apart from wind speed, wind direction also plays a crucial role especially in corridor setting. Wind rose is required for this analysis. Wind rose can be defined as the pictorial representation of wind direction from which fraction of time for a particular wind direction can be determined. Three typical wind roses are depicted in Fig. 1. For better clarity, the wind rose of Ahmadabad is depicted in Fig. 2 below. It helps in determining the most favorable wind direction of a particular location and accordingly, corridors can be oriented. It is also equally necessary to fit wind direction data into suitable statistical models such as two-component and four-component von-Mises distributions.

Wind Circulation and Corridor Setting

After orienting the corridor according to wind direction, inside circulation can also be provided. When wind flows over a bluff body, at the back of the same vortices are formed due to adverse pressure gradient and subsequent boundary layer

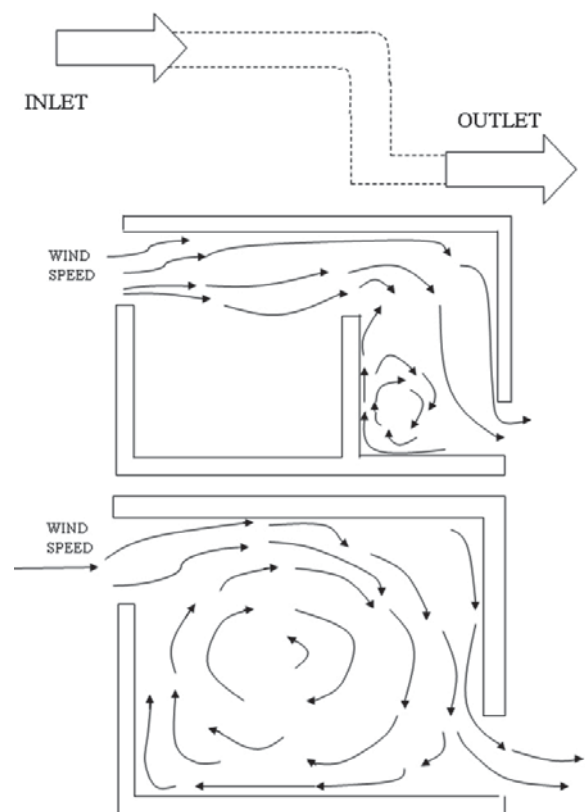


Figure 3: Wind Induced Circulation

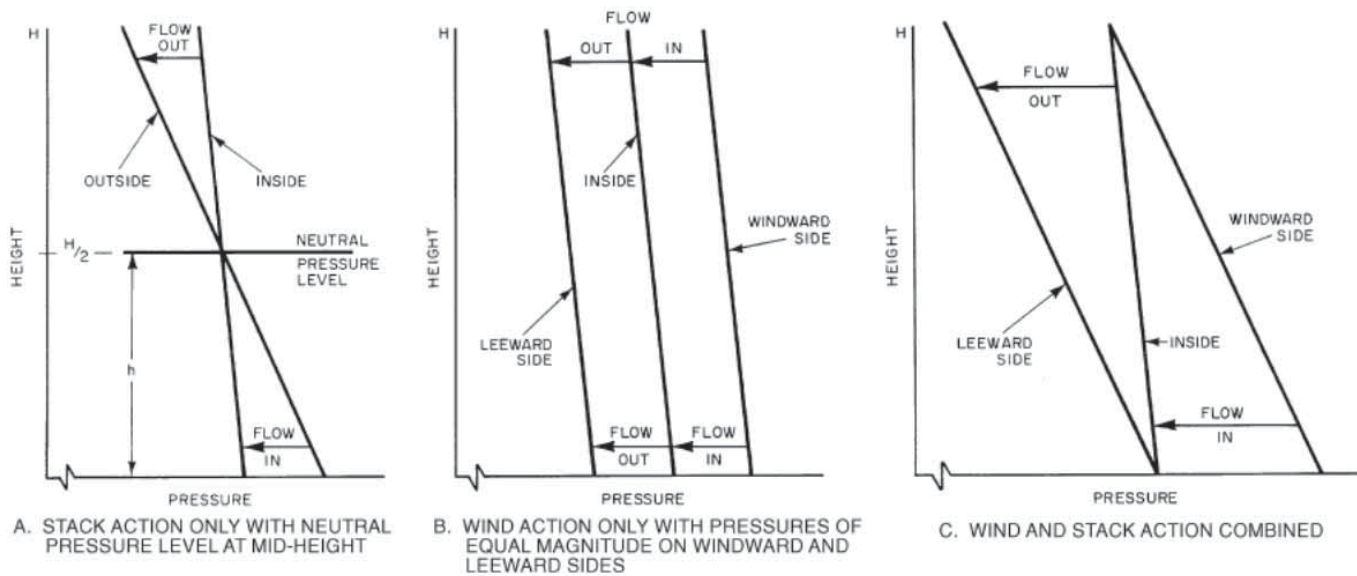


Figure 4: Distribution of Inside and Outside Pressures over Height of Building

separation. At the sharp edge also where the gauge pressure is negative, circulation occurs widely and the same also occurs at the front of the object mildly due to distortion of the stream line. This phenomenon of fluid mechanics can be used to provide natural circulation which is depicted in Fig. 3.

Now-a-days due to global warming and high level of pollution, atmospheric boundary layer changes which would lead to the change of the wind climate. The aerosols in the air also increase drastically which also absorb solar radiation. As a result, temperature increases but the irradiation on the surface of the earth becomes gradually less which would in turn affect the pressure gradient and wind flow. Hence, it may not be possible to predict wind speed and direction from probability distribution without considering the effects of climate change. Therefore, it is also required to determine the long term trend of wind speed and direction for proper predictions of the same.

Design Strategies for Natural Ventilation

As shown in Fig. 4, wind and stack action combined yields best circulation and hence the design for natural ventilation should incorporate maximizing both the wind and stack driven ventilation design concepts. General design considerations

include: (i) Increase air supply intake by ensuring no outside obstruction (such as vegetation or site objects) nor inside obstruction (such as furniture and interior partition) obstruct inlet openings; (ii) Rooms should have inlet and outlet openings located in opposing pressure zones. This can include openings on the windward and leeward walls or on the windward wall and roof; (iii) All occupied spaces should have an inlet and outlet opening in which at least a minimum of one opening should be an operable

window to control flow; (iv) Inlets should supply air at a location low in the room. Outlets should be located across the room and at a higher level; (v) The long facade of the building and the majority of the openings should be directed so that the windward wall is perpendicular to the summer wind; (vi) Use skylights or ridge vents. They are very desirable for night time thermal comfort in houses to vent heated/warm air that rises, and allow heat to be radiated into the cold. It is also can be a good outlet for wind driven



Unique system of "natural ventilation" in Lotus Temple of New Delhi is based on the principles of ancient buildings ventilation. Image for representation purpose only



ventilation; (vii) At least 3m allowance for the floor to ceiling; (viii) window areas should not be excessive and be protected by exterior shading devices; (ix) Design for high thermal capacity and exposed ceilings for night cooling; (x) Reduce the possibility of wall warming by the sun through use of light-coloured building exteriors, trees/shrubs to provide shading and evaporative cooling, grass and other groundcover to keep ground temperatures low, and ponds and fountains to enhance evaporative cooling; and (xi) Internal loading should be kept low. Many of the considerations taken above is to either increase the air

flow or lower the heat gain so that the natural ventilation can effectively cool the spaces in the building.

Clean Indoor Environment

Outside air may contain unacceptably high levels of pollutants including ozone, pollen, carbon monoxide, particulate matter, odors, toxic agents, etc. Hence, the filtering of incoming air is required to get a clean environment, which is very essential for comfort and health. The type and number of filters are generally dependent on clean room applications. The main filter groups include: (1) filters for removing solid and liquid particles (viscous

impingement and dry screen available in renewable, cleanable and throwaway variations, fibrous, electrostatic and air washers); (2) filters for removing gases and vapors (e.g. activated carbon and chemical filters); (3) filters for removing bacteria (e.g. ultraviolet or germicidal lamps). Apart from air inlet, the pollutants may enter in the air conditioning space with occupancy also and hence they are required to enter and exit the cleanroom through airlocks, air showers and/or gowning rooms, and they must wear special clothing designed to trap contaminants that are naturally generated by skin and the body.

Conclusions

Efficient cooling systems are highly required but in harmony with nature. In most of the cases, traditional cooling systems cause harm to the environment and also human health. Hence, the passive cooling system through the natural ventilation of wind can be considered as a holistic solution in place of traditional cooling system. However, large uncertainties are involved in the availability of the desired wind speed range. Climate change can also influence both wind speed and direction. Accordingly, corridors should be oriented for passive cooling and many design strategies discussed in this article have to follow. As the outside air contains large amount of dust and pollutants, the proper filtering system is needed to get fresh air. ■



Dr. J. Sarkar

Associate Professor,
Department of Mechanical
Engineering, Indian Institute
of Technology, Varanasi



Dr. A. Sarkar

Associate Professor,
Department of Mechanical
Engineering, Indian Institute
of Technology, Varanasi



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Govt Assisting 135 Integrated Cold Chain Projects

The Ministry of Food Processing Industries is presently assisting 135 integrated cold chain projects under its central sector scheme for Integrated Cold Chain and Value Addition...

The Ministry of Food Processing Industries is presently assisting 135 integrated cold chain projects under its central sector scheme for Integrated Cold Chain and Value Addition Infrastructure. Of this, 97 have achieved completion and commenced commercial operation.

Further, Government has approved taking up 100 new Integrated Cold Chain Projects in 2016-17 for financial assistance. Accordingly, revised operational guidelines for scheme for Integrated Cold Chain and Value Addition Infrastructure for taking up 100 new cold chain projects in 2016-17 have been issued on 29.08.2016. Based on the revised operational guidelines an Expression of Interest was issued on 31.08.2016 inviting applications or proposals from prospective entrepreneurs for taking up 100 new integrated cold chain projects. Total 308 integrated cold chain proposals from all over the country have been received against the Expression of Interest.

Operationalization of 135 cold chain projects envisages creation of a cold chain capacity of 5.01 lakh MT of cold storage/ controlled atmosphere/deep freezer, 116.40 MT/Hr of Individual Quick Freeze, 52.65 lakh litre per day of milk processing/storage and 766 number of reefer vehicles. Out of this, Ministry has so far created a capacity of 3.70 lakh metric tonnes of cold storage, 95.04 metric tonnes per hour of Individual Quick Freezing, 37.96 lakh litres per day of Milk processing/ storage and 552 reefer vans. A study was undertaken by National Centre for Cold Chain Development, Ministry of Agriculture and Farmers Welfare in 2015 on All India Cold-Chain Infrastructure Capacity (Assessment of Status & Gap) to assess the requirement for cold chain infrastructure in the country. The study has made the following gap analysis of cold chain infrastructure:

Type of Infrastructure	Infrastructure Requirement (A)	Infrastructure created (B)	All India Gap (A-B)
Pack-house	70,080 nos.	249 nos.	69,831 nos.
Cold Storage (Bulk)	34,164,411 MT	31,823,700 MT	32,76,962 MT
Cold Storage (Hub)	9,36,251 MT		
Reefer Vehicles	61826 nos.	9000 nos.	52826 nos.
Ripening Chamber	9131 nos.	812 nos.	8319 nos.

Thus, there is a gap of 3.28 Million Metric Ton of cold storage requirement. The study was primarily based on requirement of fruits & vegetables and has excluded the requirement for milk, meat, marine and processed products. ■

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*Proposed

Practices for Installing Compressors

Embraco has launched a digital tool, called Toolbox app that combines several features focused on providing support to contractors in a single application. The company developed main practices for installing compressors to help them in their daily work...

Embraco – multi-national focused on innovation and one of the largest manufacturers of hermetic compressors for refrigeration – wants to be part of its customers' business before, during and after the purchase. Installing and working with compressors require attention, therefore the company's Distribution and Retail segment supports sales teams, technicians and professionals of the segment as well as conducts annual surveys and promotes lectures and trainings.

Always attentive to offer innovative solutions not only in products but also in services, especially those aimed at facilitating the day to day of industry professionals, Embraco has launched a digital tool, called Toolbox app that combines several features focused on providing support to contractors in a single application. The company developed main practices for installing compressors to help them in their daily work. All the recommendations below explain the ways to work with compressors and to check if the work has been carried out with complete safety and precision.

Diagnosis and Maintenance Procedures in Cooling Systems

- Ensure beforehand that the environment for maintenance is suitable and airy.
- Have at hand the process tools and equipment.
- Use the PPE (personal protection equipment) required for your activities.
- Before starting the maintenance or diagnosis, first check that

the cooling system is disconnected from the electrical network.

- Wait for the compressor to cool, with the system already disconnected from the electrical network. Only execute maintenance or diagnostic procedures with the compressor cold ($25^{\circ}\text{C} \pm 5^{\circ}\text{C}$).
- Only connect the compressors in electrical installations with DR (Differential Residual) circuit breakers.
- Check that the installation has the correct grounding.

It should be emphasized that not disconnecting the compressor from the electrical network during maintenance procedures and the application of a system without DR circuit breaker can cause serious risks to the technician's physical integrity due to the possibility of electric shocks and/or fire occurring.

Furthermore, not disconnecting the compressor from the electrical network can, if there is a short circuit in the region of the compressor hermetic terminal, cause the hermetic pins to be expelled, causing the leakage of the cooling fluid.

Electrical Accessories

- Before removing the plastic cover protecting the electrical components, check that the compressor is disconnected from the electrical network and that start and/or functioning capacitors are used.
- Remember to never handle any electrical accessory with the compressor connected to the electrical network. Not

disconnecting the compressor from the electrical network during maintenance procedures can cause serious risks to your physical integrity, as has already been said.

- Start and/or functioning capacitors must be handled with care, as they can cause an electric shock even if they are disconnected.

- When it is necessary to remove the capacitors, disconnect them carefully, paying special attention to the exposed electrical terminals. After being disconnected, the capacitor must be discharged.

- Check that the capacitance range (μF) printed on the start and functioning (if applicable) capacitor label is in accordance



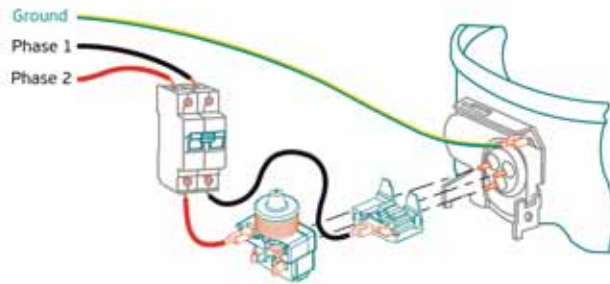


Figure 1

with the technical information of the compressor installed in the system. The VAC Voltage value printed on the capacitor must be equal to or greater than the value indicated in the technical information of the compressor. If one of the values (VAC Voltage and/or Capacitance) is not in accordance with the specification of the compressor, replace the capacitor.

- The application of an unsuitable capacitor and/or start devices (relays or PTC) not specified can cause overheating of the capacitor. Overheated capacitors are subject to rupture, which can lead to leakage of overheated material, generating risks of burns.
- When it is necessary to disconnect the electrical components of the compressor hermetic terminal, remove the thermal protector and start device (relay or PTC), applying longitudinal force on the pins. Never apply transversal forces on the pins of the hermetic terminal.
- The inappropriate removal of these accessories can cause poor contact in the electrical connection, damage the hermetic terminal and cause the pins to be expelled leading to the leakage of the cooling fluid and oil.
- Compare the code printed on the thermal protector, relay or PTC with that of the technical information of the compressor. If the code is different, replace the component outside the specification. There are no universal or similar electrical accessories. Always use the model specified in the technical information of the compressor.
- Remember that start devices (relays or PTC) not specified can cause overheating of the capacitor. Overheated capacitors are subject to rupture with the consequences already mentioned.
- The use of thermal protector or start device (relay or PTC) differing from the one specified can generate a short circuit in

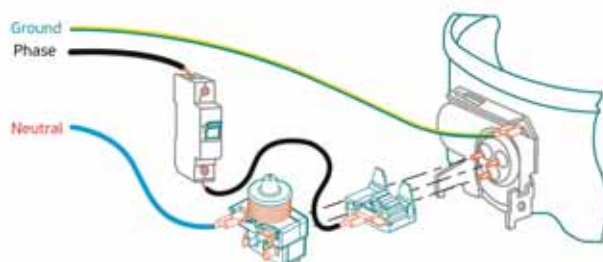


Figure 2

the region of the compressor hermetic terminal. This can cause the hermetic pins to be expelled, leading to the leakage of the cooling fluid.

Electrical Installation

In single-phase installations, the Phase wire must be protected by a circuit breaker and connected to the thermal protector. The Neutral wire must be connected to the start device (relay or PTC). The system must be grounded. This situation is presented in the Figure 1.

While in two-phase installations, as shown in the Figure 2, it is mandatory to use the two-pole circuit breaker. With this, in the case of a short circuit both the power supply phases will be protected. The system must be grounded.

Not using a two-pole circuit breaker leaves the compressor susceptible to short circuit in the region of the hermetic terminal, being able to cause the hermetic pins to be expelled and lead to the leakage of the cooling fluid. Bear in mind, also, that in systems without grounding there are risks of electric shock.

Replacing the Compressor

If it is necessary to replace the compressor, pay attention to the following safety recommendations:

1. Check that the compressor is disconnected from the electrical network. Not disconnecting the compressor from the electrical network during the maintenance procedures can expose the technician to the risk of electric shock and fire.
2. Never remove the compressor before removing all the cooling fluid from the system. For this operation, it is advisable to use a fluid collecting machine. In the case of flammable fluids, ensure that small accumulations of cooling fluid of the system are removed, as they can generate risk of fire.
3. Use a pipe cutter to disconnect the pipes of the compressor. Under no circumstances use the blowtorch flame to disconnect the compressor pipes. Using a blowtorch in compressors with flammable cooling fluid can cause fire and release toxic vapors.
4. In case of burning of the compressor and/or internal contamination of the system, clean the piping with an appropriate solvent, applied as per the manufacturer's technical guidelines. Non-compliance with the solvent manufacturer's technical guidelines can expose the technician to risks of fire and intoxication.
5. Before connecting a compressor ensure the following:
 - The voltage on the compressor label is appropriate for the electrical network and the electrical installation is in accordance with that described in the topic 'Electrical Installation'. The application of a compressor at the incorrect voltage can generate a short circuit in the region of the hermetic terminal, with the consequences described previously.

The plastic protection cover of the electrical components must be suitably fitted. Not using or positioning this plastic cover inappropriately generates a risk of electric shock and fire. ■

Bio-Chillers for Rural Development

The paper justifies the application scope of biogas as a fuel for traditional vapour absorption refrigeration systems. Both environment and economics benefits can be achieved when biogas is used as a source of energy for refrigeration.

In the current situation the energy demand is increasing with burgeoning population. Energy is the crucial input to the development of any country. The International Institute of Refrigeration in Paris (IIR/IIR) has estimated that approximately 15% of all the electricity produced in the whole world is employed

for refrigeration and air-conditioning processes.

In a tropical country, like India, refrigeration is the most widely used and generally the most energy consuming process. In general, refrigeration is defined as any process of heat removal from a place for preserving foods and medicines

by enhancing its shelf life.

Farmers mostly dairy farmers who sell their products to export markets, refrigeration could play an important role to increase their annual income. Without cooling capabilities the dairy products have to be sold immediately after taking from animals. This reduces the chance of negotiating good prices, because the buyer is in a better bargaining position. Particularly in these sectors, farmers have the potential to produce a lot of biogas through available cattle dung. Biogas based refrigeration technology would be a good opportunity for such farmers to take maximum benefits.



Bio-Chilling System

Cooling effect is produced by the evaporation of a refrigerant. Heat is used in different ways to operate a refrigerator system for evaporating the refrigerant in the cycle. Biomass energy is a good source especially for agro based rural areas where a lot of organic materials are being wasted. Extraction of bio-energy with carbon neutral process is possible. As regular hike in the conventional fuel prices like LPG and CNG, biogas serves a good source of fuel for refrigerators. Bio-chilling denotes that heat is produced through any conversion process of biomass such as biogas, producer gas etc to operate a refrigeration cycle. Biogas refrigeration technology can be classified into mainly two categories: electrical refrigeration and thermal refrigeration.

Kim *et. al.*(2008) & Hwang *et. al.* (2011) have provided with a broad overview of the various technologies available to use non-conventional energy for refrigeration purposes which includes electric, thermo-mechanical, sorption and some newly emerging technologies. They have also compared the potential of these different technologies in delivering competitive sustainable solutions.

A bio-electric refrigeration system consists mainly of electric generator and a compressor based refrigeration unit. Biogas is used as fuel to generate electricity. The biggest advantage of using bio-generator for refrigeration is the ease of operation and high overall efficiency when combined with a conventional vapour compression system. Winrock International, Pakistan installed a biogas based vapour compressor milk chilling unit during the year 2012-13. They installed 4 biogas plants: two plants of 50m³ and two plants of 100m³. The milk chillers run on electricity with capacity of 500 litres and 1,000 litres for eight hour. But high initial investment is the major issue for the development of this technology.

Bio-thermal refrigeration system uses heat produced from burning of biogas. Based on sorption principle, this type of system uses physical or chemical

attraction between a pair of substances to produce refrigeration effect. A sorption system has a unique capability of transforming thermal energy directly into cooling power. Among the pair of substances, the substance with lower boiling temperature is called sorbate and the other is called sorbent. The sorbate plays the role of refrigerant. This category is further classified into two streams as absorption systems and adsorption systems.

Room for Research

A few designs of absorption refrigeration system are commercially available which operates on conventional fuels. However, there appears to be a lack of products specifically designed to operate on biogas. A simple way of using biogas for refrigeration is by adapting commercial absorption refrigerators. In this situation, the burner in the refrigerator needs to be modified in order to deal with the safe and controlled combustion of biogas with its impurities and the varying levels of methane content. Without modification, chances of components failure are more. Remote ignition via a piezoelectric element substantially increases the ease of operation.

Apart from the physical modification, energy analysis will also play an important role in the further modification towards energetic optimization. In this regard, an

evaluation based on first law and second law of thermodynamic gives result in point energy loss and identify the reversibility that lead to energy destruction. The second law analysis recognises that heat energy has a lower availability than work energy.

Biogas based Absorption Refrigeration System

Vapour Absorption Refrigeration Systems (VARS) belongs to the class of vapour cycles. The absorption refrigeration cycle consist of a generator, condenser, evaporator, absorber, expansion valve and pump as shown in Figure 1. During one cycle the refrigerant passes through four main stages:

- In the evaporator, the fluid refrigerant evaporates by extracting heat from the product or room being refrigerated.
- The evaporated refrigerant flows into the absorber where it mixes with the secondary fluid.
- The resulting solution is then driven into the generator, where it is heated. This heat causes the refrigerant to vaporise.
- The resulting vapour passes into the condenser, where it returns to liquid state and is ready to start a new cycle.

Srikhirin *et.al* discussed various designs of vapour absorption refrigeration system. Rao *et.al.* studied the thermodynamic simulation and analysis

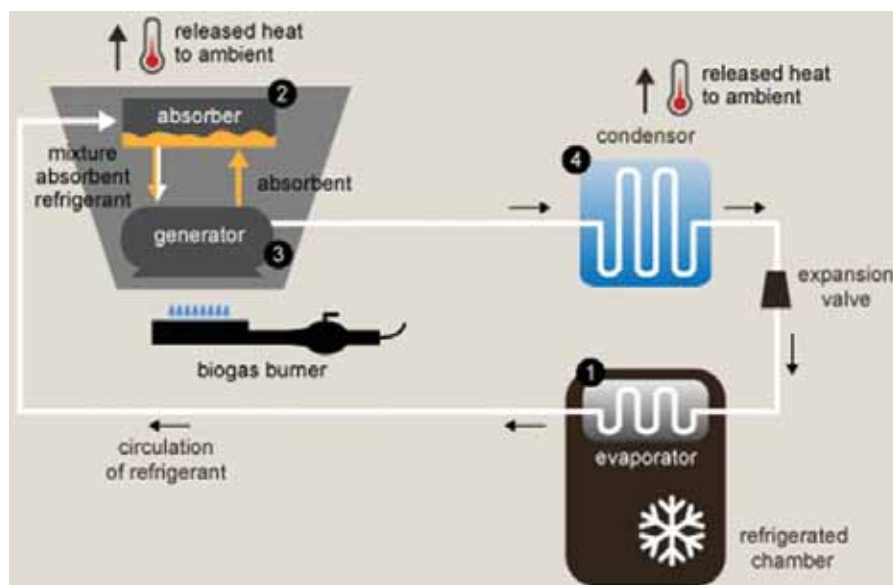


Fig.1 Schematic view of biogas based absorption refrigeration system.
(<http://www.wisions.net/technologyradar/technology/biogas-refrigeration>)

the biogas operated double effect ammonia water based GAX absorption refrigeration system. A computer code was developed for computing the effect of temperature and pressure of the high temperature generator and the pressure of the evaporator over the COP for a constant condenser and absorber temperature. It was suggested that biogas can be used to operate the absorption cycle.

It is estimated that one kerosene refrigerator emits between 900 kg CO₂ per year. Biogas based refrigeration can replace conventional refrigerators and offers a sustainable solution for cooling using renewable energy.

Conclusion

There are some commercial products are available based on heat driven refrigeration processes. The basic

principles of heat driven refrigeration have long been known but the market for heat driven cooling is still small. Technologies for generating cold from biogas seem to be an innovation field with significant potential. Harnessing this potential would require serious effort in terms of research, development and bringing the technology to market.

Key areas to focus in order to improve the overall performance of heat driven refrigerators are efficiency improvements of the different systems and the possibility of the joint operation of various refrigeration cycles. Modification ensures user-friendly operation and maintenance. In the case of users who can produce their own biogas, switching to biogas can result in economic benefits in the medium term, due to the savings made in fuel costs. However, there are currently too few biogas refrigerators in use to provide concrete figures.

The gas demand for refrigeration varies depending on the outside temperature. A 100 litres volume refrigeration system needs about 2000 litres of biogas per day to down the temperature from ambient to five degree Celsius. A large household refrigerator consumes about 3000 litres of biogas per day. ■

Er. Kapil Samar
Research Engineer cum
Project Manager
Biogas Development and
Training Centre, Udaipur



Dr. Deepak Sharma
Project Coordinator
Department of Renewable Energy
Engineering, Maharana Pratap
University of Agriculture and
Technology, Udaipur



EU's Move on Clearer Energy Efficiency Labelling Rules

Consumer surveys show that about 85% of European citizens look at energy efficiency labels when they purchase products. Having the best performing ones in the A+ to A+++ categories was misleading and hid potential substantial differences in energy performance. Giving consumers more accessible information about the energy consumption of products and appliances will make it easier to identify the most efficient appliances.

Vice President for Energy Union Maroš Šefčovič said, "Technological innovations allow European citizens to enjoy the most advanced products on the market; it was therefore high time to bring our labelling scale up to date. The new labels will be empowering consumers to take energy efficiency into account when choosing their next electric products."

Commissioner for Climate Action and Energy, Miguel Arias Cañete, added: "This deal is good news for Europe's consumers and businesses, our energy bills and the climate. The revised energy efficiency label – together with ecodesign – can save households close to €500 per year, increase manufacturers and retailers overall revenue by over €65 billion per year and save to the annual energy consumption of Italy and all the Baltic countries combined."

Main achievements:

- A return to the clearer A to G class label, by removing the cumbersome A+ to A+++ classes from existing energy labels within a well-defined timeframe;
- The introduction of a product registration database to support market surveillance activities by the Member States;
- A public database containing all energy efficiency labels, gives consumers a better tool to compare the energy efficiency of household appliances;



Energy efficiency first is a central principle of the Energy Union strategy. Energy efficiency is an effective way to cut emissions, bring savings to consumers and reduce the EU's fossil fuel import dependency. Since its introduction twenty years ago, the success of energy labelling has encouraged the development of ever more energy efficient products. This has resulted in the current label becoming too complex. In July 2015, the Commission has proposed returning to the original A to G energy label scale, simpler and well understood by consumers. ■

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Turning Waste Heat to Electricity

Berkeley Lab is partnering with Alphabet Energy to create a cost-effective thermoelectric waste heat recovery system to reduce both energy use in the industrial sector and electricity-related carbon emissions. ICF International estimates that such a system could save California 3.2 million megawatt-hours per year in energy while also increasing electrical reliability...



Waste heat from industrial facilities will be captured and efficiently converted to electricity using a system by Berkeley Lab and Alphabet Energy

Vast amounts of energy are wasted every year in the form of heat. A new project led by the Department of Energy's Lawrence Berkeley National Lab (Berkeley Lab) seeks to efficiently capture that heat and convert it to electricity, potentially saving California up to \$385 million per year.

With a \$2-million grant from the California Energy Commission (CEC), Berkeley Lab is partnering with Alphabet Energy to create a cost-effective thermoelectric waste heat recovery system to reduce both energy use in the industrial sector and electricity-related carbon emissions. ICF International estimates that such a system could save California 3.2 million megawatt-hours per year in energy while also increasing electrical reliability. The funding comes from CEC's Electric Program Investment Charge (EPIC) program, which funds clean energy innovation to reduce pollution, foster economic development, and meet the state's climate goals.

"The potential to create electricity from waste heat in California has not been tapped significantly due to the lack of suitable waste-heat-to-electricity conversion technology," said Ravi Prasher, Director of Berkeley Lab's Energy Storage and Distributed Resources Division.

"Thermoelectrics is one of the most promising technologies for waste heat conversion out there, but the biggest challenge has

been to find a reliable and cost-effective material that can work at high temperatures." Industrial facilities, such as power plants, cement plants, mining and manufacturing facilities, and oil and gas operations have more than 763 megawatts (MW) of electricity-generating potential from waste heat in California, and national potential is approximately 15,000 MW.

However, most current thermoelectric materials are limited by several factors including high cost, low efficiency, and the inability to operate reliably at temperatures above 400 degrees Celsius.

The new Berkeley Lab project, co-led by Prasher and Vi Rapp, a mechanical research scientist in the Energy Technologies Area, is working to overcome these barriers. In collaboration with Alphabet Energy, they will develop a cost-effective process for creating an advanced thermoelectric material constructed from silicon nanowire arrays.

Thermoelectrics harvest exhaust heat from engines, furnaces, and other sources of waste heat and convert it to useful energy without generating additional greenhouse gas emissions. Commercially available thermoelectrics achieve less than five percent efficiency in converting heat to electricity. The technology has already seen some market traction in the oil and gas and automotive industries.

Alphabet Energy is a Hayward, California-based startup that launched in 2009 using nanotechnology licensed from Berkeley Lab. They are developing advanced thermoelectric materials based on silicon nanowires with conversion efficiencies of 10 percent or greater and the ability to operate at temperatures up to 800 degrees Celsius. "With the increase in efficiency, other market opportunities in waste-heat-to-power could be accelerated," Rapp said.

The higher operating temperature also opens up new possibilities, such as increasing the power produced from capturing high-temperature waste heat from gas flares. The CEC funding will enable Berkeley Lab and Alphabet Energy to develop a prototype device and validate its performance for high temperature heat-to-electricity conversion. "Our objective is to develop a new system that has very few parasitic losses, is more compact, is modularized for a broad scale of distributed applications, and will reliably produce additional electricity with almost no maintenance cost or operator involvement for many years," Prasher said. "We believe it will make waste-heat-to-power viable and affordable in a wider spectrum of applications."

Well Oiled Safety

The new oil level regulator INT280 Diagnose by KRIWAN sets new standards for reliability in oil management: Compressor operation is becoming significantly reliable by the implementation of Industry 4.0 concepts.

For the long-term reliable operation of compressors, it is important that there is always the right amount of oil in the compressor – enough, but not too much. Oil shortage quickly leads to mechanical wear and overheating. Too much oil on the other hand may cause liquid slugging that may cause severe damage to the compressor. At the same time, the challenges for the implementation of the oil management are increasing: The use of frequency converters in compressors results in much stronger fluctuations in oil consumption of the compressor, and the increasing use of CO₂ systems makes for a much wider spread in both absolute and differential pressure.

Foam generation is also changed for the new refrigerants and pressure ranges. This makes it more important to be able to adapt and adjust the oil level regulator more precisely for the specific application. In addition to these more recent challenges, there are also some well-known issues in oil management that require further improvement. For example, run detection is often requested to ensure that the oil level regulator does not seemingly perform a safety shutdown when the compressor is turned off and the high pressure is reduced. Finally, especially, in some regions of the world, contaminated oil remains a cause of many problems.

Refrigeration/AC 4.0 in Oil Management

The Internet of Things and Industry 4.0 are much discussed topics these days. Many aspects of these developments remain rather vague though. With the new INT280 Diagnose, KRIWAN is introducing a product for the refrigeration/AC market that makes Industry 4.0 more practical and concrete. In addition to its basic function – measuring the oil level and adding oil – this regulator is characterised, especially, by the fact that it captures valuable data that it uses for its own operation but is also able to communicate.

The most important value is, of course, the oil level in the compressor. This can be determined in various ways, for example, by optical sensors or floating switches. In the age of Industry 4.0, the KRIWAN optical measuring cell offers a key benefit: It has an active transmitter diode and a passive receiver diode. The transmitter diode sends an infrared beam through a glass prism.

Depending on the oil level, the receiver diode receives a stronger or weaker signal (see Fig. 1). The new product generation exploits the fact that the transmitter diode is an active component. It can receive a stronger or weaker control signal, which enables it to measure additional data with this modulation: Usually, the diode is operated at only 10% of the maximum transmission power. This is enough to reliably measure the oil level. Now the transmission power is periodically raised to 100%. If contamination in the refrigeration circuit has formed deposits on the glass prism, this can

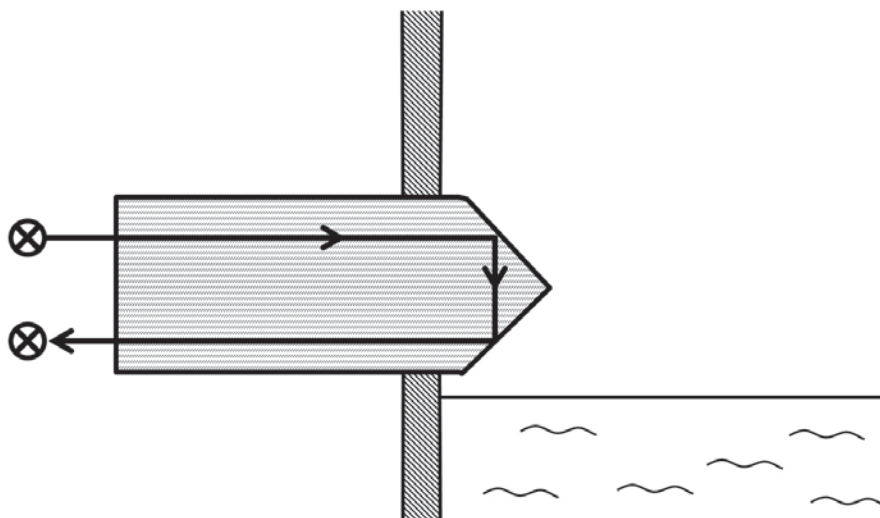


Figure 1: Active optical oil level monitoring

be detected by changing the transmission power. For one, the minimum transmission power in the regulator is increased from 10% to compensate for the contamination. On the other hand, the information is also sent via the diagnostic interface. For the first time, the influence of oil on the sensor can be read out on a smartphone or at the refrigeration regulator. In addition to monitoring the glass prism, the INT280 also monitors the correct function of the transmitter diode, the receiver diode, and possible interference of external light. This means that the entire sensor is equipped to monitor itself. Every technical system and every sensor can be damaged or deteriorated and ages. Self-monitoring makes it possible to detect such states early on.

These aren't all the benefits of the new INT280 Diagnose however: The data interface to the refrigeration/AC controller (circular connector in Fig. 2 to the upper right of the oil nipple) is able to transmit other information as well: Because the K_v value of the oil level regulator (flow in m^3/h) is a known constant, the oil consumption rate of the compressor can be calculated when the differential pressure and the oil density are known. This becomes even easier if not the exact value in m^3/h is needed, but only the relative ratio of compressors in a rack (e.g., compressor 1 carries over twice as much oil as compressor 2). Then the oil density is an equal parameter, and with properly symmetrical piping, the differential pressure can be assumed to be roughly equal for all oil level regulators. With this method of estimating the oil consumption rate, only the different opening times of the valves in the individual regulators need to be compared, and these times are delivered from the INT280 Diagnose to the controllers via the data interface.



Figure 2: INT280 with diagnostic interface

The interface can be used not only for reading out data from the controller. The INT280 Diagnose can also be set individually: Filling or idle times can be adjusted, as can a specific refill time. This allows the regulator to be adjusted optimally for the various pressure ranges, the oil viscosity, and the operating points of different systems. All this – adapting and reading out data – is easily done in the field using a smartphone, or by factory programming on a PC.

Another option is to combine the new INT280 Diagnose with an INT69 Diagnose compressor protection relay by connecting the two modules using a Y-cable and the two diagnostic interfaces. Other adjustments or settings are not required. The INT280 oil level regulator automatically detects if it is connected to a compressor protection relay.

It continuously receives information whether the compressor is running or whether it has been switched off by the refrigeration/AC controller. In some field applications it may happen that no oil can be refilled when the

compressor is switched off because the high pressure is dropping. Even though there still is oil in the collector, it cannot flow through the open valve. The oil level regulator detects what seems to be an error ("oil cannot be refilled successfully despite low oil in the regulator").

It switches off and locks the compressor. With the new run detection, this can no longer happen: The compressor is not switched off in this situation. The INT280 executes its protective function and switches off only if the compressor is running and no oil can be refilled even though there is pressure.

Oil management is critical for the compressor. The new INT280 Diagnose makes this topic easier and more reliable. When the regulator works not only on a small control circuit but is able to communicate with the refrigeration/AC controller and the compressor protection relay, then that is Industry 4.0: The controller is also used as a sensor and provides valuable data for optimizing the entire refrigeration/AC circuit. ■

Selection of Air Conditioning System

The distinction between the local DX and central chilled water systems is critical from a mechanical, architectural and energy management perspective. Let's analyze the key factors that determine the selection of (DX) direct expansion system. The write up is for the benefit of fresh engineers to do sales and design of AC system.

Unitary air conditioner systems have a largest voluminous product in the market segment throughout the world. As the business volume is high and very less people are involved in selection, sales and execution, the product

knowledge and its awareness towards the right choice of selection and application are limited to fresh engineers. All are working as product sellers.

Now that we understand the conceptual arrangement of air-conditioning cooling

systems, the distinction between the local DX and central chilled water systems is critical from a mechanical, architectural and energy management perspective. Let's analyze the key factors that determine the selection of (DX) direct expansion system. The write up is for the benefit of fresh engineers for sales and design of AC system.

DX System

Check out this statement "DX system is suitable for a single thermal zone application". What does this mean?

Why is it so?

To answer this, first understand the concept of thermal zone. A thermal zone is referred to a space or group of spaces within a building with heating and cooling requirements that are sufficiently similar so that desired conditions (e.g. temperature) can be maintained throughout using a single sensor (e.g. thermostat or temperature sensor). Each thermal zone must be 'separately controlled' if conditions conducive to comfort are to be provided by an HVAC system. Few examples below illustrate and clarify the concept of a zone.

- In a building, the perimeter areas with large glazing & exposure are prone to larger solar radiation. Such areas shall experience higher heat load than the indoor core spaces and must be separately controlled.
- In a commercial building, the space containing electronic processing equipment such as photocopiers, fax machines and printers see much larger heat load than the other areas and hence, it is a different thermal zone.
- A conference room designed for 50 people occupancy shall experience lower temperatures when it is half or



quarterly occupied. The design, thus, shall keep provision for a dedicated temperature controller for this zone.

- In an airport, a smoking room shall be categorized as an independent zone for health and safety reasons. A good air-conditioning system should not allow mixing of smoke contaminants with return air of other public lounges.
- A 1000 seat theatre shall be treated an independent zone than the entrance concourse or cafeteria as the dynamics of occupancy are different.
- A hotel lobby area is different from the guest rooms or the restaurant area.
- A hospital testing laboratory, isolation rooms and operation theatre demand different indoor conditions or pressure relationships than the rest of areas and thus shall be treated as a separate zones.
- A control room or processing facilities in industrial set up may require a high degree of cleanliness/positive pressure to prevent ingress of dust/hazardous elements and thus may be treated as separate zone.

In nutshell, any area that requires different temperature, humidity and filtration needs or is prone to huge variations in thermal loads shall be categorized as an independent zone. The reason that most modern offices interiors have low partitions is not to do only with aesthetic and spacious looks; it has relevance to keep air-conditioning simple and effective. Zoning may very well be categorized as an architectural responsibility since it requires a good understanding of building function and schedules.

Let's check out why DX systems are only suitable for single thermal zone application. The reasoning is as follows:

1. DX systems do not provide modulating control. The capacity control in DX system with fully hermetic sealed compressor is, generally, accomplished by cycling the compressor ON and OFF in response to the signals from a thermostat. What this means is that the DX system will only have one point of control – typically a thermostat. Thus, two rooms with

thermostat controllers set at say 22°C and 28°C shall conflict with each other or in other words the two rooms cannot achieve the set conditions unless the rooms are served with independent units. Semi-hermetic compressors offer the benefit of being able to unload pairs of cylinders within a single compressor. For instance, a compressor with six cylinders can be staged to operate at 100%, 67% and 33% capacity by operating on six, four, or two cylinders respectively. These provide only limited step modulation. Presently, multiple scroll compressors are installed ductable split models to take care of part load in place of semi hermetic reciprocating compressor, which also aims at reducing the compressor power load.

The issue of system control leads to the concept of HVAC zoning just like architectural zoning. Active HVAC system may be designed to condition a single space or a portion of a space from a location within or directly adjacent to the space.

2. DX systems cannot be networked conveniently. The refrigerant piping plays a key role in connection of various components in terms of size, length and pressure drop. Split units installation is restricted by distance criteria between the condensing unit and the evaporator, which is usually 30 to 40 feet for smaller units and around 100 to 120 feet for larger units. For large buildings consisting of multi-zones, DX system may be viewed as collection of multiple independent units placed at different locations in a distributed network with each unit working in isolation.

Each DX system is, thus local self-contained unit consisting of its own compressor/s, evaporator coil, fan, condensing unit and filtration unit. Depending upon the capacities required and areas served the DX system could be room air conditioners, split air-conditioners or package air conditioners. All these serve a single thermal zone and have its

major components located in one of the following ways:

- Within the zone
- On the boundary between the zone and exterior environment
- Or directly adjacent to the zone

Newer DX Configurations/Options

Newer technology has found ways to combat the above weaknesses if not fully at least substantially.

New Refrigerants

As the technology is getting more advanced day by day, new eco friendly refrigerants are getting replaced. The operating parameters are not the same; the selection and installation are more complicated. The older refrigerant models have become absolute and customer goes for long lasting air conditioners due to its cost. Hence, a lot of care is desirable.

Variable Air Volume (VAV) Units for Ducted Package Systems

Variable Air Volume (VAV) components can be fitted on the air distribution ductwork, thus affording good control of conditions within the respective thermal zone. Variable air volume system (VAV) delivers a constant temperature of air and responds to changing thermal loads by varying the quantity of supply air.

Generally, such a fitment on the whole system means a large increase in cost. In a limited mode, like for instance just one cabin to be zoned out in a full floor - one can install a VAV diffuser for the cabin. Such a device has a motorised damper fitted on the air outlet and the damper operates automatically in response to a thermostat. In other words, the diffuser admits or restricts supply air to the cabin in response to the command of a thermostat. Such devices cost about Rs.15, 000 approximately for a 400 cfm size diffuser.

Variable Refrigerant Flow (VRF) System for Multiple Evaporators

The term variable refrigerant flow (VRF) refers to the ability of the system to

control the amount of refrigerant flowing to the multiple evaporators, enabling the use of many evaporators of differing capacities and configurations connected to single condensing unit.

The arrangement provides an individualized comfort control, and simultaneous heating and cooling in different zones. This refrigerant flow control lies at the heart of VRF systems and is the major technical challenge as well as the source of many of the system's advantages.

Many zones are possible, each with individual set point control. Because VRF systems use variable speed compressors with wide capacity modulation capabilities, they can maintain precise temperature control, generally, within $\pm 1^\circ\text{F}$ ($\pm 0.6^\circ\text{C}$), according to manufacturers' literature.

VRF system being the split installation is restricted by distance criteria between the condensing unit and the evaporator. Although few manufacturers' literature states the refrigerant lines can be as long as 500 feet, but when you read the fine print, after the first 'Tee' from the condensing unit, you are limited to 135 feet to the furthest unit. Other than the restricted distance criteria between evaporator and condensing unit, there are some legitimate concerns that need to be addressed.

- VRF systems are complete, proprietary systems from the controls right up to the condensing units, refrigerant controllers, and all the system components other than the refrigerant piping. That means users do not have the flexibility to use anybody's building control and automation system to run these systems. You'll need a BacNet or Lonworks black box to connect from your building DDC system to the VRF system, and you can only monitor what it's doing, you can't control it.
- As the system has a larger spread, the refrigerant pipes traverse long lengths - hence their pressure testing and protection becomes critical. Long refrigerant piping loops also raise concerns about oil return.
- Long refrigerant lines also raise the potential of refrigerant leaks, which can be a safety hazard. The refrigerant leak, especially, if the system serves small

rooms can cause oxygen depletion. So, you need to limit the system size within reasonable limits based on smallest room area served. For e.g. if the room area is 100 sq-ft, you would need to limit the refrigerant quantity under less than about 30 lbs. Contractors are concerned about long refrigerant piping runs for multiple evaporators.

In these systems, compliance with ANSI/ASHRAE Standard 15, Safety Standard for Refrigeration Systems, is difficult;

- Currently, no approved ARI standard exists for a performance rating of VRF systems. Consequently, manufacturers need to apply for waivers from the Department of Energy to market their products in the US. Although these waivers have been granted, new applications need to be submitted for new product groups;
- VRF systems are expensive and complex. The complicity involved in VRF/VRV is continuous and have to be dependent on the vendor who has supplied for life of equipment.

Multiple Compressors

A unit with two equally sized fully hermetic compressors may operate at 100% and 50% capacity by starting or stopping one of the two compressors. Unequally sized compressors provide greater staging flexibility, for instance, a 30-ton unit with three compressors rated at 10 tons and 20 tons will have capacity stages at 33%, 67% and 100%.

Applications

- The DX systems are suitable for small or medium sized buildings free of multiple thermal zones and demanding 100 TR or less of air-conditioning. For big areas such as mall type stores requiring say 200 TR of refrigeration, DX system may be viewed as 4 units of 50 TR each subject to availability of space and aesthetics.
- DX systems are more effective for the services requiring low temperature and low humidity conditions. The



application includes the grocery stores, fruit & vegetable stores, meat processing units, instrument rooms, laboratories, bio-medical labs, critical manufacturing and process facilities.

- DX systems can be applied along with central chilled water system for areas requiring 24 hours operation such as server rooms, data centres etc. DX systems can be also be applied for augmenting the HVAC needs in the existing central HVAC systems necessitated due to expansion or addition of more equipment.

Factors Favouring DX System

- One of the most common reasons for selecting a DX system, especially, in smaller buildings is the lower installed cost than a chilled-water system because it requires less field labour and has fewer materials to install.
- DX systems tend to be distributed for larger buildings that increase reliability; a building conditioned using DX system may have a dozen or hundred of individual and independent units located throughout the building. Failure of one or two of the units may not impact the entire building. On a smaller scale this may be viewed as a disadvantage unless standby is provided.
- If the tenants are paying the utility bills, multiple packaged DX units may make it easier to track energy use, as only the specific unit serving that tenant would be used to meet the individual cooling requirements.
- DX systems are not complicated by interconnections with other units. Maintenance of local systems tends to be simple and available through numerous service providers.

- In buildings where a large number of spaces may be unoccupied at any given time, such as dormitory, small hotels etc. the local DX systems may be totally shut off in the unused spaces, thus, providing potential energy savings.
- For small areas within full scale offices like communication rooms or server / computer rooms, where it is necessary to have 24 hour air conditioning - it is possible to have independent split, ancillary AC units exclusively for these areas.
- DX systems can be installed quickly and their operation is relatively simple. Often short delivery schedules are generally available as factory standard off the shelf unit. Easy to install and replace. Compact and require a smaller footprint than alternatives.
- As a self contained system, a DX system may provide totally individualized control options, for instance, if one room needs heating while an adjacent one needs cooling, two local systems can respond without conflict.
- DX unitary systems are ideal for retrofitting applications. These may be used to supplement areas of inadequate service by a building's existing central system.
- Air cooled condensers can be located on the roof of a building or even within the perimeter wall of the building. Cooling unit is available in wide variation of floor, wall as well the ceiling suspended unit.
- DX units have capacity control limitations; compressor unloading systems are generally step devices, which limit capacity modulation. At low load conditions, the compressors will cycle and unconditioned air will pass through the system during the off cycle, which may cause temperature swings (i.e. hot and cold spots) in the conditioned space;
- The coefficient of performance (COP) of a DX system is low. Unitary systems consume more power (kW per ton) compared to central systems of same capacity;
- Lack of interconnection between units also means that loads cannot be shared on a building wide basis. Central HVAC systems deliver improved efficiency and lower first cost by sharing load capacity across an entire building;
- One cannot have a zone within a zone. As an example in a general office, air conditioned by a DX system - if there is a cabin or two - these cabins cannot have individual independent controls (unless variable air volume (VAV) units are considered);
- Multiple DX systems using window or small capacity split units may spoil the exterior elevations and aesthetics of the building;
- For distributed DX systems, although the maintenance may be relatively simple, such maintenance may have to occur directly in occupied building spaces;
- DX systems may not be suitable for the applications requiring high air delivery rates and the areas requiring significant positive pressurization (unless the DX systems are engineered). The standard unitary systems provide 400 cfm of air delivery capacity per ton of refrigeration;
- DX systems are not suitable for areas requiring high degree of cleanliness unless the systems are custom built. The standard units, generally, provide fan static pressure of 2 to 3 inch water gauge, which may not be sufficient to cope up the resistance of high efficiency filtration.
- DX systems installation many a time requires plumbing arrangements with in the conditioned area if the cooling unit is placed indoors. The design should take into account the condensate removal required from the conditioned space and the possibility of leakage.
- DX window or small split-air conditioners are free air discharge units and are non- ducted. Multiple units or package unit shall be needed to optimize air distribution where the span of building (length or width) exceeds 12 feet.
- Smaller split units with cooling (evaporator) unit located indoors in conditioned space are 100% re-circulation units. They do not provide ventilation, so a separate ventilation system is necessary.
- Split DX systems are constrained by distance limitation of approximately 30 to 100 feet between condensing unit and evaporator. Chilled water systems are not constrained by any separation distance criteria between chiller and the cooling coil.
- Special requirements of surface coating may not be available on the condensing equipment placed outdoors in harsh corrosive/saline environment. The condensing unit will, therefore, have a shorter life span.
- Multiple DX systems for large area applications shall require larger footprint of mechanical room or quite a number of mechanical rooms.

Limitations of DX System

- DX systems cannot benefit from economies of scale. Capital costs and the operating costs generally tend to be higher for larger setups requiring 100TR or more. The building designer must thoroughly evaluate all pertinent installation, operating, and maintenance costs to make an informed decision
- DX systems cannot be easily connected together to permit centralized monitoring or energy management operations. These can be centrally controlled with respect to on-off functions only

Conclusion

The HVAC industry largely human is dependant in the field in case of selection, design, installation as well as service. If all have been done perfectly, the desired cooling required by the customer can be achieved. The customers satisfaction mostly manufacturer dependant and not with the engineer or technician concerned. ■

R Muralidharan Iyengar
Principal Faculty
AC& R Training,
Chennai



Dwyer SMART Air Hood Balancing Instrument

The Series SAH SMART Air Hood Balancing Instrument is the most accurate and easy to operate air hood flow available in the market. By using the included hood stand and wireless communications to the



handheld, a single operator can balance a branch in less time than traditional balancing teams. Besides being lighter than most traditional capture hood, the ergonomic design makes the Series SAH easy to manoeuvre with less physical stress.

The rugged polypropylene base hood features patented Quad Flow Design Technology for controlling air flow and minimizing back pressure which yields superior measurement accuracy. The Wi-Fi direct communications gives reliable communication with a distance of up to 200 yards between the hood and the handheld test instrument.

The SMART hood balancing instrument includes the PredictAir Application Software which reduces the number of steps in the air flow balancing process using Predictive Balancing's Express Balance mode. Predictive balancing is a method of predicting the optimal flow set point for each register and the other in which they should be adjusted.

Features/Benefits

Patent pending Quad Flow Design Technology directs the circulating air patterns to provide a more even air flow that minimizes backpressure enabling accurate readings.

Predictive balancing is a process that

guides the balancing technician on setting the optimal flow set point for each sequential terminal. With the PredictAir Application Software, the balancing process takes much less time than traditional air balancing methods.

The ergonomic design is much lighter and easier to work with than the existing bulky air hoods, providing better manoeuvrability and less physical strain. One technician can complete the air balancing.

Wi-Fi directs wireless communication provides a range up to 200 yards.

Application

Commissioning, testing, adjusting and balancing volumetric air flow from diffusers, grilles and registers in HVAC systems.

ALM Engineering and Instrumentation Pvt Ltd is a brand ambassador for Smart Hood in India. ■

Email: info@alмонтazar.com

Climaveneta's Optimized Heat Pumps for Heating

Air cooled reversible heat pump, with axial fans and inverter driven compressor, for heating water up to 60°C and operating limit down to -20°C outdoor air temperature.

The Climaveneta system is based on an packaged external units with integrated hydronic module and by an internal unit with the electronic regulation. The i-KIR2 heat pumps provide for heating, cooling and domestic hot water production. Particular care is taken for winter mode, that thanks to the Inverter technology is guaranteed beyond traditional units working limits, water production up to 60°C. The i-KIR2 reverse-cycle heat pumps feature high seasonal efficiency



in both heating and cooling mode, using DC inverter technology to modulate compressor operation and deliver the exact amount of energy based on the actual needs of the building. This excellent result has been achieved by carefully sizing all the components.

Features

System Efficiency

The unit is designed as a system: all components are regulated using proprietary control's logic for the highest efficiency.

High Efficiency at Partial Load

High seasonal efficiency in both heating and cooling mode using DC inverter technology to modulate compressor operation and deliver the exact amount of energy based on the actual needs of the building. High efficiency for low energy consumption

during the operating hours.

High Efficiency Components

In terms of improving performance and reducing power consumption, the electronic thermostatic valve is an important component that maximises system efficiency, same for the choice the hydronic kit with inverter water pump and the modulating the fans speed with DC motor as standard equipment.

Extensive Operating Limits

Particular care is taken for winter mode that thanks to inverter technology is guaranteed beyond traditional units working limits, supplying hot water up to 60°C and down to -20°external air.

Integrated Hydronic Module

The integrated hydronic include all the water circuit components so as to optimize installation space, time and costs. ■

Forthcoming Events At A Glance

2017 ASHRAE Annual Conference

Venue: Long Beach, CA

Date: 24th to 28th June 2017

Website: www.ashrae.org/longbeach

ASHRAE Annual Conference 2017

Venue: Hyatt Regency Long Beach, CA, USA

Date: 24th to 28th June 2017

Website: www.ashrae.org

Cleanroom Guangzhou 2017

Venue: China Import and Export Fair Complex

Date: 16th to 18th August 2017

Website: www.clcte.com

Mostra Convegno Expocomfort 2017

Venue: Marina Bay Sands, Singapore

Date: 12th to 14th September 2017

Website: www.mcexpocomfort-asia.com

SIFA 2017

Venue: Les Dock De Paris, France

Date: 3rd to 5th October 2017

Website: www.expo-sifa.com

2018 AHR Expo

Venue: Chicago

Date: 22nd to 24th January 2018

Website: ashrae.org/AHRExpo2018

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Shanghai Tower with Dual Green Building Certifications in China

Shanghai Tower, China's tallest and most sustainable super high-rise building, includes several of Johnson Controls' building technologies, contributing to its high energy efficiency and its achievement of being the first green building in China certified with both LEED Gold and Three-Star Green Building Design Label.

After eight years of construction and opening in phases in 2016, the Tower features 43 sustainable technologies overall, including more than 10 YORK chillers and heat pumps, a Metasys BMS and a Johnson Controls central performance management system (CPMS) in the building's central heating



and cooling plant. The customized CPMS controls the tower's cooling and heating system, which accounts for 30 percent of the energy consumed by the building. The system performs real-time calculations to optimize energy use based on the current workload and operating conditions, improving the building's energy efficiency in the process. The 2,073 foot tower also relies on nine YK water-cooled centrifugal chillers, three YK dual-operation water-cooled centrifugal chillers and one YEWS screw geothermal heat pump to provide heating and cooling throughout the nearly 4.1 million-square-foot skyscraper. ■

Oslo Airport Hosts World's Greenest Terminal

In Oslo, work has been completed on the world's greenest air terminal which combines innovative design with energy efficient strategies as well as on-site energy harvesting systems. Designed by the Nordic-Office of Architecture, the 115,000 square metre expansion to Oslo Airport has set new standards for sustainable design.

The extension – which has increased the airport's capacity at to more than 30 million passengers – is the world's first airport building to achieve the BREEAM Excellent sustainability rating.

The renovation showcases a range of energy-efficient strategies in addition to energy harvesting systems. The terminal uses a reservoir of snow gathered during the winter months to



cool the building throughout the summer. Natural materials have been used wherever possible and recycled steel and special, environmentally friendly, concrete mixed with volcanic ash has been used throughout the building. The use of environmentally friendly materials has resulted in an estimated 35 per cent reduction in CO₂ emissions. Furthermore, energy consumption in the new expansion has been

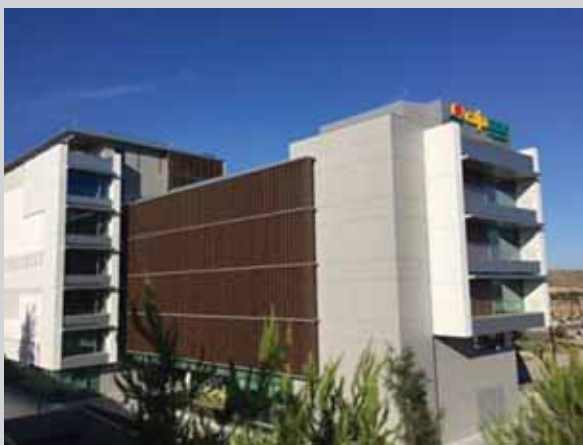
cut by more than 50 per cent compared to the existing terminal.

The Nordic team has also updated the existing train station – which sits at the heart of the airport – enabling 70 per cent of all passengers to access the airport by public transport. ■

Cajamar HQ now LEED Gold Certified

The new Cajamar office building, a 19,600 square meter architectural colossus in Almeria, Spain, obtained the LEED GOLD certification, in full compliance with the bank environmental policy.

Many architectural and plant engineering choices were carried out with this purpose. The HVAC is based on a 4-pipe air to water system, set with variable speed. One multi-purpose i-FX-Q/SL-CA 0802 unit for the simultaneous production of heating and cooling with inverter driven compressors and two TECS2/SL-CA-E 0512 chillers with magnetic levitation compressors have been installed there. Air is



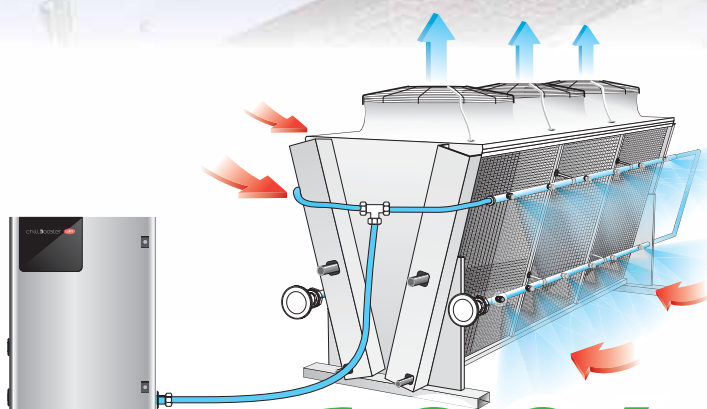
distributed in the offices through high head fan-coils, in a built-in version, a-LIFE2 HP to ensure perfect comfort all year round.

The whole HVAC system is managed by ClimaPRO, the new chiller plant control with active optimization. The Climaveneta supply is completed by 4 close control units for the data center cooling: 4 i-ADU 50 dual fluid, inverter unit, air condensed with lower air intake. Close control units are connected to chillers for the

primary water circuit and to the primary remote condensers on the roof for the secondary direct expansion or backup circuit. ■

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