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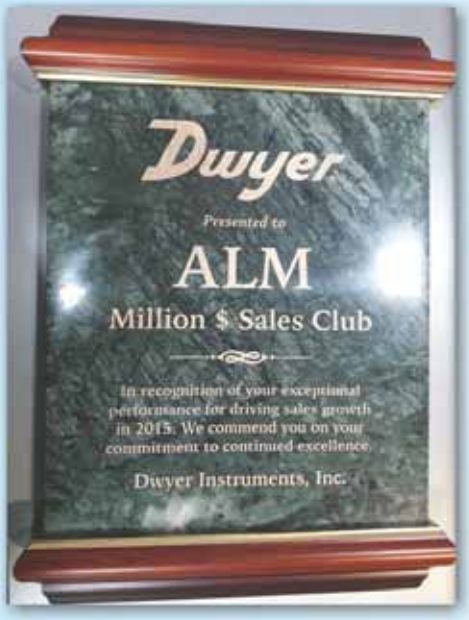

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Publisher's Letter

Gear Up For The Coming Days

Industrial refrigeration systems find applications mainly in the food processing, oil and gas, and chemicals and pharmaceuticals industries. Though industrial refrigeration systems are very similar to commercial and residential refrigeration systems, certain parameters, like size, refrigerant, system types and load temperature are different.

A recent report from Research and Markets has communicated that the global industrial refrigeration market will grow at a CAGR of 6.72% during the period 2016-2020. Obviously, it's a good news for the refrigeration vendors, other ancillary product suppliers and the community.

The report also states that in the last decade, the industrial refrigeration market has undergone considerable change. Mergers have played a big part in this transformation, with several larger companies acquiring refrigeration contracting companies. This has led to the creation of several global refrigeration companies.

In this age of communication, the people from all the parts of the world are aware of the huge losses of the agricultural produces. Thus, everywhere there is a wave of preventing this loss, and improving the agro products' supply chain. In India too, several efforts are being instituted to address this concern in a big way. Here, the problem of storing and transportation of the agro products is still very acute.

Similarly, in the pharmaceutical sector too, we need to drastically improve the logistics. There are certain drugs that not only need to be kept cold, but also are required to be within a certain temperature zone – where we need much improved refrigeration support.

Thus, there is no doubt that in the coming days, the global refrigeration companies will get good business in this sub-continent. However, the local SME contractors will need to enhance their capabilities, especially they need to build their financial strength, which is possible only through joint effort.

Please send your comments at pravita@charypublications.in

Pravita Iyer
Publisher & Director

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FROM THE EDITOR

Are We Ready?

Recently, the European Commission (EC) presented their first ever strategy to optimise buildings' and industries' 'heating and cooling', a sector accounting for 50% of the EU's annual energy consumption. By making the sector smarter, more efficient and sustainable, energy imports and dependency will fall, costs will be cut and emissions will be reduced. The strategy is a key action of the Energy Union Framework Strategy – and will contribute to improving EU's energy security and to addressing post-COP 21 climate agenda.

In this context, the EC refers to 'heating and cooling' as the energy needed for warming and cooling buildings, be them residential or in the service sector (e.g., schools, hospitals, office buildings). It also includes the energy that is necessary in almost all industrial processes to produce products they use in their everyday life as well as cooling and refrigeration in the service sector, such as the retail sector (for example to preserve food across the supply chain from production, to supermarket and to the customer).

Their strategy includes some vital points, like making renovating buildings easier, increasing the share of renewables, reuse of energy waste from industry, getting consumers and industries involved… Contextually, almost half of the EU's buildings have boilers installed before 1992, with an efficiency rate of below 60%; 22% of gas boilers, 34% of direct electric heaters, 47% of oil boilers and 58% of coal boilers are older than their technical lifetime.

As per EC, the renovation of the existing buildings could lead to lower energy consumption; but, the refurbishment rate is currently below 1%. Obviously, the condition is not very different from India. So, for us also, it is high time that we strategically go for refurbishment and/or replacement of the old HVAC products, if we truly want to achieve our climate goal.

Also, with fast growing supermarkets and malls in our country, a time has come when we should seriously consider the ways to arrest and reuse the escaping heat from them. As per a recent communiqué from Danfoss, "2016 will see a continued growing interest in trans-critical CO_2 systems with heat reclaim." Are we ready to accept that?

Pl. send your views at pkchatterjee@charypublications.in

P. K. Chatterjee

It is high time that we strategically go for refurbishment and/or replacement of the old HVAC products…

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Editor: P K Chatterjee

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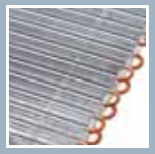




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MIAL inducted into the maiden ACREX Hall of Fame powered by Danfoss

R.Purushothaman (5th from L), President, Danfoss India and Dr. A. Mathur (6th from L), TERI Chief acknowledging team members from MIAL, Blue Star and L&T for the MIAL project...

Mumbai International Airport Ltd (MIAL) project received the honour of being the first organisation to be inducted into the Hall of Fame at ACREX 2016, one of India's largest industry exhibitions. The team behind the success of the project, which includes GVK CSIA, L&T, Blue Star received the honour on behalf of the stakeholders involved in the making of MIAL in a glittering award ceremony held in Mumbai.

ACREX Hall of Fame is an industry benchmark instituted by Danfoss India in partnership with ISHRAE (Indian Society of Heating, Refrigerating and Air Conditioning Engineers) to recognize the excellence achieved in conserving energy by commercial buildings in the Indian subcontinent.

The coveted recognition aims to encourage energy efficiency among industry stakeholders and showcase success stories in the HVAC space in India. This prestigious award showcases CSIA as an energy efficient and sustainable HVAC venture. ■

Ethisphere Institute names Rockwell the most ethical company

The Ethisphere Institute has recognized Rockwell Automation, the world's largest company dedicated to industrial automation and information, as a 2016 World's Most Ethical Company. This is the eighth time that Ethisphere, a global leader in advancing the standards of ethical business practices, named Rockwell Automation to the distinguished list which recognizes companies who align principle with action, work tirelessly to make trust part of their corporate DNA, and in doing so, shape future industry standards by introducing tomorrow's best practices today.

"Companies rely on Ethisphere to continually raise and measure the standards of corporate behaviour. Those, like Rockwell Automation, that demonstrate leadership in areas like citizenship, integrity and transparency create more value for their investors, communities, customers and employees, thus solidifying a sustainable business advantage," explained Ethisphere's Chief Executive Officer, Timothy Erblich. This year marks the tenth anniversary of Ethisphere and the World's Most Ethical Companies designation.

"The importance of ethics and the transparency of integrity, both ingrained in our culture, continues to increase for current and potential employees," said Keith D. Nosbusch, Rockwell Automation Chairman and CEO. ■

Integrated Comfort expands its operations

Dual Cool unit...

Integrated Comfort, Inc. (ICI) moved from Vacaville, Calif. to a larger office and production facility in West Sacramento, Calif in June 2015. ICI also opened a facility in Phoenix, Arizona to provide manufacturing and logistical support in one of our higher concentration areas for Dual Cool installations. Between July 2015 and January 2016, ICI completed the installation of Dual Cool evaporative pre-coolers on 100 more Walmart and Sam's Club stores.

Each of these stores now has Dual Cool equipment on six or more 10- to 20-ton rooftop HVAC units (RTUs) that supply dedicated fresh air into the stores. Installations were in Arizona, Utah, New Mexico, Texas, Nevada, and California. The 2015 program is the fourth major series of Dual Cool installations for Walmart.

Current campaign with Walmart takes Dual Cool efficiency, maint. and ease-of-use to a whole new level with monitoring and controls. ■

Blue Star to set up two new state-of-the-art manufacturing plants

Blue Star Limited is in the process of setting up two major manufacturing facilities to redesign and augment its manufacturing footprint. These will be located at Samba in Jammu and Sri City in Andhra Pradesh. The company plans to invest Rs 215 crores over the next 3-4 years towards this exercise, which will increase its overall production capacity by about a million units towards the final phase.

Blue Star had embarked on a manufacturing footprint programme with the help of KPMG. Consequent to that exercise, the company closed down its Thane and Bharuch plants. Thus, currently, the company has five plants in Wada, Dadra, Ahmedabad and Himachal Pradesh. Whilst the Plant at Sri City is proposed to be built on around an area of 20 acres, the Samba factory is to be constructed over 24 acres. These factories will primarily manufacture room airconditioners, deep freezers and water coolers.

The facility at Samba would enable the company to avail of the excise duty exemption for a period of 10 years from the commencement of production. Apart from planning to avail State GST benefits for intrastate sales, the Sri City Plant would lead to considerable savings in logistics costs since a significant proportion of airconditioner sales of the company is from the South. It would also de-risk the products business due to the spread of its manufacturing footprint in two different states.

The significant enhancement in Blue Star's manufacturing capacity will help cater to the burgeoning demand in the domestic as well as export markets. Procurement of land followed by plant construction is proposed to start immediately for Samba to enable it to commence operations by FY18. Land procurement is expected to begin at the earliest for Sri City with the plant construction planned in a phased manner to start operations by FY19.

The new factories are planned to be world-class manufacturing hubs with superior aesthetics and ergonomics, deploying state-of-the-art technology. These modern and contemporary plants will ensure that the products manufactured are not only globally competitive but also set new benchmarks in manufacturing technology in the country. ■

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Carrier Singapore to distribute next-generation Toshiba Variable Refrigerant Flow (VRF) system

Carrier Singapore Pte Ltd. (Carrier Singapore) has launched the Toshiba Super Modular Multi System-e (SMMS-e), a next-generation variable refrigerant flow (VRF) system that combines industry-leading energy efficiency with expanded capacity loads and a smaller modular footprint. Carrier, quite well known in high-technology heating, air-conditioning and refrigeration solutions, is a part of UTC Climate, Controls & Security, a unit of United Technologies Corp. Carrier Singapore distributes Toshiba air conditioning products in Singapore as part of a global alliance agreement between the two businesses.

The SMMS-e is the next generation model of the Toshiba VRF system and boasts a number of system enhancements, including an expanded single outdoor unit capacity, as well as an expanded combination capacity. Driven by high-volume compressors and Toshiba's high-performance inverter, the product is now one of the most energy efficient in the industry. The SMMS-e has a single unit outdoor capacity of up to 22HP, which enables building owners to save on the footprint occupied by each system, with a reduced number of combined modular units necessary to obtain a high capacity.

An ideal system to support green building development, the SMMS is designed to help meet increased demand for high-efficiency building systems that use less energy and lower the overall carbon footprint of buildings.

"We are delighted to distribute yet another innovative Toshiba cooling product that specifically caters to the needs of our customers in the Southeast Asia region," said Oon Wee Chin, President, UTC Climate, Controls & Security, Southeast Asia.

UTC Climate, Controls & Security is a leading provider of heating, ventilating, air conditioning and refrigeration systems, building controls and automation, and fire and security systems leading to safer, smarter, sustainable and high-performance buildings.

UTC Climate, Controls & Security is a unit of United Technologies Corp., a well known provider to the aerospace and building systems industries worldwide. ■

New CHP plant commissioned

The CHP plant runs on the natural gas producing 1.2 kW of thermal energy per kW of power...

BPC Engineering has completed a project for mini CHP plant installation in Nysh village, Sakhalin Region. The plant consists of a 600-kW ENEX 600 power system and a UT-65 heat recovery system with 0.75 MW of thermal output as the main source of heat supply.

Two hot-water boilers, 0.42 MW each, supply additional thermal energy during peak hours. The equipment is arranged in a single building located in the territory of the village. Within the framework of the project BPC manufactured the ENEX power system and performed equipment supply, installation supervision and the commissioning of the mini CHP plant.

The installation was motivated by laying a new gas pipeline to the village. The plant replaced an outdated diesel plant that was the reason for multiple outages in the remote community. ■

Sun Hung Kai Centre saves 10% on energy cost

Johnson Controls' comprehensive building solution has enabled 34-year-old Sun Hung Kai Centre, a 53-story mixed-use development and headquarters of leading developer Sun Hung Kai Properties, to achieve energy and cost savings of around 10%, and reduce its carbon footprint by 300 tons / year. This translates to annual savings of close to USD 75,000 with an anticipated return on investment of only two years.

Sun Hung Kai Properties is a pioneer in the application of new green technologies. The centre is among the few buildings in Hong Kong that has achieved the 'Excellent' certificate awarded by the Hong Kong Environment Technology Centre, as well as achieved global certification from the International Standards Organization (ISO) for its accomplishments in improving quality and environmental management. ■

Blueair's product to receive a global innovation award

Aware air quality monitor...

At the intersection of design, health and technology, the cool-looking Aware air quality monitor from Sweden's Blueair has been chosen as a finalist for a Global Innovation Award at the International Home + Housewares Show in Chicago. Blueair, a globally well company in indoor air purifying technologies and solutions, designed the Aware to quickly detect hundreds of different types of airborne particles, including everything from PM2.5 to VOCs, such as formaldehyde and benzene in home and workplace environments.

"The Blueair Aware enables people to monitor your indoor air in real-time, track data overtime, and get alerts from your Smartphone with the Blueair Friend App," said Herman Pihlträd, President of Chicago-based Blueair Inc. To help eliminate allergy triggers, the Blueair Aware also monitors room humidity and temperature.

Noting that indoor air can be up to 100 times more polluted than outside air, Pihlträd said the Wi-Fi enabled Blueair Aware uses sensors to measure indoor air pollution. The semi-conical device, just six inches high, shows indoor air quality in six levels visualized by the colour on an LED bar, with deep blue indicating excellent air quality and dark orange revealing highly polluted air.

The air quality information harvested by the Blueair Aware air quality monitor can be read on the Blueair Friend app, which allows IOS or Android user either to manually adjust the airflow speed of a connected WiFi-enabled Blueair air purifier or permit automatic adjustment.

The air quality information harvested by the Blueair Aware air quality monitor can be read on the Blueair Friend app, which allows IOS or Android user either to manually adjust the airflow speed of a connected WiFi-enabled Blueair air purifier or permit automatic adjustment of the device. ■

Blue Star announces changes in top level management

The Board of Directors of Blue Star Ltd has appointed Vir S Advani as Managing Director and B Thiagarajan as Joint Managing Director, both with effect from April 1, 2016. The current Managing Director, Satish Jamdar, will retire from the Board on March 31, 2016.

Vir S Advani has been with the Blue Star group of companies since 2000. Having initially managed a number of independent assignments in associate companies, he joined Blue Star Ltd in 2007. He made valuable contributions in several senior staff and operational positions before being appointed to the Board in 2010 as Executive Director. In this role, he took charge of the troubled Electro-Mechanical Projects business, turned it around and revamped it during the extended downturn over the past several years.

B Thiagarajan has many years of experience in the airconditioning and refrigeration industry in India. He joined Blue Star 17 years ago and progressively took charge of after sales service, marketing, manufacturing and R&D of the AC&R products business. He was elevated to the Board as Executive Director in 2013. Under his

Vir S Advani

B Thiagarajan

dynamic leadership, the products and service business has grown consistently with steadily increasing market share and profitability, while making Blue Star a preferred choice of consumers. ■

Powers of Arkansas make changes in its leadership team

Recently, three key leaders have been promoted in the commercial HVAC company, Powers of Arkansas. All of them have contributed leadership and vision to the growth of the company as the industry leader in commercial HVAC equipment, air distribution, and controls in Arkansas.

Steve Keen, formerly President of HVAC and Controls, has been promoted to President of Powers of Arkansas. Steve will use his unique experience to propel Powers forward in the HVAC equipment, air distribution, and controls markets. Keen has been with Powers of Arkansas for 10 years and will continue to contribute his expertise in this new leadership position.

Ron McCarty has been a key member of the Powers team as a customer account manager for the last six years. He has been very successful in helping the company in building the controls division into the largest in Arkansas – and also has a key role in customer relations. McCarty is being promoted to Vice President of Controls – where he will continue to grow the company's controls division.

Thomas Luyet, formerly Director of Technology, has been with Powers for 24 years, and is known as the best technical engineer for

controls in Arkansas. In his new role as Director of Controls, he will ensure that the controls team uses the industry's best practices. Luyet will also provide training to both employees and customers on new controls technology.

(Courtesy: SEND2PRESS NEWSWIRE)

John Kramer

AHRI inducts John Kramer to the Board of Directors

John Kramer, President and Chief Executive Officer of Cambridge Engineering, the well known manufacturer of energy efficient High Temperature Heating And Ventilation (HTHV) direct-fired gas products for commercial spaces, has been appointed to the Air Conditioning, Heating, and Refrigeration Institute's (AHRI) Board of Directors.

Kramer is the son of the founder of Cambridge Engineering. He said, "I'm humbled by this appointment to the industry's trade association and to be engaged and supportive in their activities. AHRI is a fantastic advocate of quality manufacturers and allows me to have a voice and show support for growing the HVAC industry."

Preventing Fresh Produce Spoilage

By actively reducing exposure to ethylene, a large amount of food spoilage could be avoided. FRESH – Fresh produce through Reduction of Ethylene during Storage and Handling is a project that is targeting to reduce this loss...

Every year, fruit and vegetable waste from production, transport, storage and retail leads to a loss of more than 620,000 tons of produce amounting to more than DKK 3bn in Denmark alone. The build-up of ethylene in the air in confined spaces, where fruit, vegetables and flowers are stored, contributes significantly to food spoilage. Ethylene is a natural signalling molecule, which is released during the ripening of fresh produce, and even small concentrations of ethylene speed up the ripening process and lead to higher concentrations of ethylene, faster ripening etc. Therefore, a chain reaction leading to over-ripening is activated.

By actively reducing exposure to ethylene, a large amount of food spoilage could be avoided. A collaboration between Blue Ocean Robotics, Aalborg University, Develco Products, Danish Technological Institute, Gartneriet PKM, Alex Andersen Ølund, Aarstiderne and Dansk Supermarked has been established with the aim to develop a solution that enables efficient monitoring and control of ethylene levels during production, transport, storage and retail of fruit, vegetables and flowers.

The developed solution will contribute to a significant reduction in fresh produce spoilage. The project is funded by the Innovation Fund Denmark:

Investment from Innovation Fund Denmark: DKK 10.7m

Total project sum: DKK 18.6m

Duration of the project: 3 years starting March 2016

Official project title: FRESH – Fresh produce through Reduction of Ethylene during Storage and Handling

The project will be based on state-of-the-art technologies within sensors, photocatalytic surfaces and UV-LEDs. Based on design parameters obtained from newly developed computer models capable of simulating flow properties as well as interactions between molecules and active surfaces, the surface and sensor elements will be further developed and combined into an air-monitoring and -cleaning unit.

Integrating the developed air-cleaning system with a network of modern ethylene sensors and other air quality sensors will enable improved monitoring and control of ethylene levels. In that way, spoilage originating from unwanted over-ripening due to ethylene can be avoided. Blue Ocean Robotics will be the main driver in the production of the air-cleaning unit, while Develco Products will be a driver in the development of the sensor control systems.

"The identification of an inexpensive sensor solution that can monitor ethylene will make it possible to use multiple sensors to map the ethylene levels in larger areas such as in containers or warehouses. Combining enhanced monitoring with a highly efficient air-cleaning solution (that can remove ethylene without some of the inherent downsides of solutions based on, e.g., ventilation or the use of ozone), will give a solution that can save resources and money in Danish companies that produce and handle fruit, vegetables and flowers", says Jacob Ask Hansen, Senior Project Leader at Danish Technological Institute.

By improving the monitoring and control of ethylene in the presence of fruit, vegetables and flowers, a significant amount of the current food waste could be avoided. Furthermore, 20% of the Danish export is comprised of foodstuff, and 20% of this foodstuff is products that are ethylene sensitive such as fruit, vegetables and flowers.

Therefore, the project can strengthen the ability of export businesses to deliver fresh products of highest quality. In addition, Danish technology-based companies such as Blue Ocean Robotic and Develco Products will obtain a significant advantage in the global competition by gaining access to solutions that are beyond state-of-the-art within sensors and air-cleaning solutions. ■

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Resolution : 60 x 60
Total Pixels : 3600
Shortest Focal Length : 20° x 20° / 0.5m
Thermal Sensitivity : 0.15 °C
Temperature Range : -20°C ~ 300°C (-4°F ~ 572°F)
Measuring Accuracy : ±2% digital / ± 2°C
Wavelength Range : 8 ~ 14 µm
Emissivity : 0.1 ~ 1.0 (Adjustable)
Image Storage : Card (4GB)
Memory Card : Micro SD Card (installed)
File Format : BMP

Meco Meters Private Limited

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ER-032016

Keeping Cool Without Electricity Or Water

Today every person needs air conditioning or air cooling, however, there are many people who can't afford either and have to suffer extreme discomfort – when their houses turn into a virtual oven in the summer, resulting in sickness and even death...

For every person using air conditioning or air cooling, there are many more who can't afford either – and have to suffer extreme discomfort when their houses turn into a virtual oven in the summer, resulting in sickness and even death.

This article contains the photos and the results of the experiment on an extremely simple roof cooling system. All it involves is to cover the roof during the day by a low emissivity cover and withdrawing it at night, exposing the roof for cooling by radiation to the sky.

A Building will receive about five kilowatt hours of heat per day for every square metre of its surface exposed to the Sun. The cover blocks over 90% of it.

The experiment was conducted on a 0.5 Sq. Mtr. Slab. The opening and closing were manual. Several variations were tried; the results were recorded using a data logger that gave output in Excel format, which allowed presentation by charts.

The results show that in every case, the slab bottom temperature remained below 34 Deg. C. or lower. Since this is below the human skin temperature, there is no heat transmitted by the roof to the occupants. Cooling the roof also prevents its heat from spreading into the rest of the building. An architect or an engineer can easily transform this flimsy demo into a robust system that covers whole roofs.

Please note that the system does not use any electricity or water. The results hereafter are proof that it actually works. The only energy required is for opening and closing the cover only twice in a day if it is made automatic.

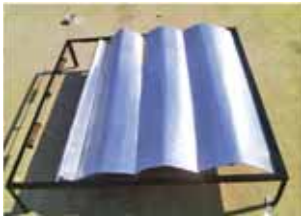
Finally, while this system will provide a huge relief from heat stress to people who can't afford air conditioners or air coolers, it will also cause a substantial reduction in the energy consumption of air conditioners.

OPERATION

COVER OPEN...

NIGHT TIME

During the night, the cover is retracted and the slab remains open to the sky. This allows radiant heat transfer from the slab to surface that is at 30 Deg C. to the sky that can be minus 40 to minus 60 Deg. C – depending on haze and clouds. The rate of heat loss in a city is about 100 watts per square meter. So, the slab bottom cools down to 27 Deg. C.



COVER CLOSED...

DAY TIME

From Sunup to Sundown, this flexible cover, with a very shiny bottom, is drawn over the slab. It shades the slab, while its low emissivity (0.01) due to the shiny surface prevents any radiant heating of the slab. So, even though the slab gains some heat from the ambient air, its bottom still remains below 30 Deg. C. – at least five degrees below the body. So, it feels cool enough to be free of heat stress.

CONCLUSION

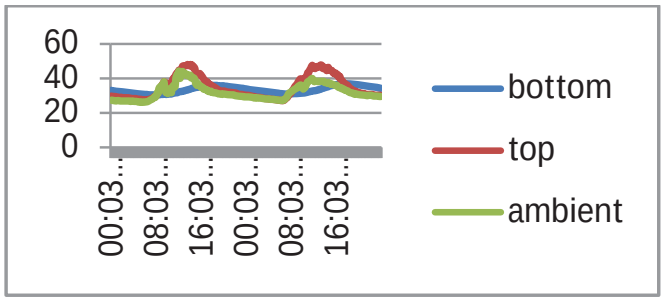
Even though both the setup above and the larger frame below are crude devices for demonstrating a principle, it would be fairly easy to translate it into a practical system.

A fully operational technology is available for blinds and curtains, both manual and automatic. It should not take much R&D or engineering to morph it into a horizontal configuration. If a similar cover is rolled down when a wall is sunlit and pulled up at night, it would then shield the entire house from the sun and keep it very cool. However, the aesthetics must be solved first.

Due to its high penetration potential, this simple idea, based on our traditional wisdom of cooling the structure for thermal comfort, not the air, can save energy, water and the environment to a large extent. It will also save the foreign exchange by reducing fuel and air conditioner imports. It would also greatly reduce CO_2 emissions. This would meet the need for thermal comfort. Greed is always insatiable, so air conditioning is here to stay.

CHARTS FROM DATA LOGGER READINGS

EXPERIMENT 1 - COVER ALWAYS OPEN

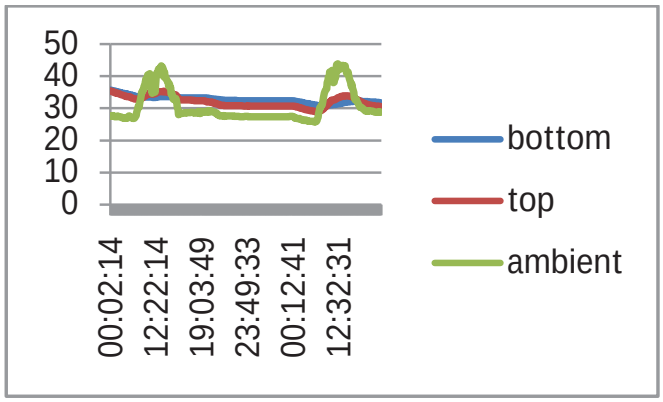


These readings were taken in early April when the ambient temperatures were low.

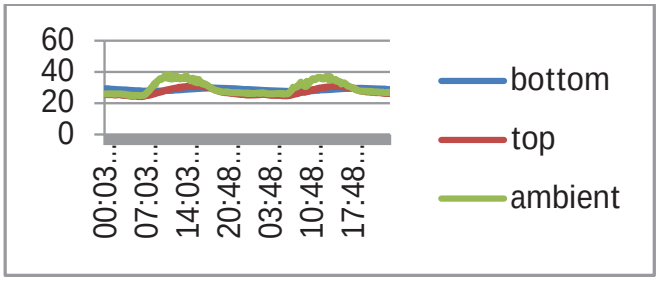
The blue line showing the slab bottom is always above 30 Deg. C. The average is very near the body temperature. Therefore, it does not feel cool.

EXPERIMENT 2 – COVER ALWAYS CLOSED

Here the slab bottom is cooler because of shading from the sun.



However, there is no cooling by night sky radiation. So, the temperature is still always above 30 Deg. C



EXPERIMENT 3 - SLAB COVERED BY DAY & OPEN BY NIGHT

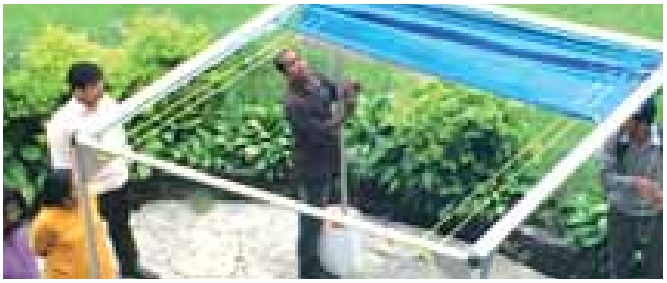
In this case, the shade prevents heating during the day and promotes cooling by sky radiation at night.

The combined effect maintains the slab bottom temperature to be always below 30 Deg. C., that is over five degrees below the body, so it is quite comfortable.

A NEW 8FT. X 8 FT. FRAME

Top view...

Shiny Bottom Cover closed for shade during day...



Cover open at night For sky cooling, this is yet to be tested...

Surendra Himatlal Shah
Director
Panasia Engineers Pvt. Ltd.

CSR

Nestlé adds 3 new potable water plants in Pakistan

This brings the total number of clean drinking water facilities constructed by Nestlé to 8 from which more than 50,000 people benefit every day. The company has also supported the community in building a social block in one of the girls' schools and applying distemper paint at 3 schools that have already been constructed...

Nestlé Pakistan has inaugurated 3 new Clean Drinking Water facilities in Khanewal, Kabirwala and Village Allahabad in Pakistan. The plant in Allahabad was inaugurated by John Martin Miller, Vice President, Regional Management for Zone AOA (Asia, Oceania and Africa), and Bruno Olierhoek, Managing Director, Nestlé Pakistan. The other plants were inaugurated by DCO Khanewal, Khalid Mehmood Sheikh and DPO Khanewal, Jahanzeb Nazir Khan, respectively. Now, some 30,000 people living in the area around the facilities will have free access to clean drinking water. Nestlé Pakistan has also announced that it would be maintaining the plants itself to ensure consistency of quality in the drinking water.

This brings the total number of clean drinking water facilities constructed by Nestlé to 8 from which more than 50,000 people benefit every day. John Miller reiterated the Nestlé commitment to engaging with the communities based around its areas of operation and said, "Improvement of access to water and sanitation is just one of the many ways in which we add value to the communities we operate in."

John Martin Miller

The company has also supported the community in building a social block in one of the girls' schools and applying distemper paint at 3 schools that have already been constructed. Currently, construction of one more school is underway in Basti, Allahbad, a community located opposite the Nestlé Kabirwala Factory. ■

Energy consumption is one of the biggest cost drivers in supermarkets. The ambition with the Smart Store concept is therefore to enable net-zero stores or even stores that supply more energy than they use. "With smart and integrated solutions for compressors, refrigerated display cases, cold rooms, HVAC, lighting and with external grids, we can offer energy savings of up to 50% with the Smart Store solutions," says Henrik Schurmann, VP Danfoss Food Retail.

The first place to start looking for energy savings is the compressor pack that typically accounts for 30 to 50% of the store's energy consumption. Numerous studies and experiments have shown that compressors only need to run on full speed about 10% of the time to meet the cooling demand. The rest of the time, the compressors can run at a lower speed and still deliver the required refrigeration capacity. Frequency converters and suction pressure optimisation are some of the measures brought into play to save up to 30% on the energy bill. By adding heat reclaim to the compressor pack, the savings can be even bigger.

"There is a huge waste of energy from the compressor pack, when only about 30% of the installed compressor capacity is actually used for refrigeration. This leaves an untapped energy reservoir that can be used for heating of the store premises, hot water is fed into the local district energy network. Our Smart Store solution seeks to exploit the surplus heat by introducing heat reclaim. The returned energy savings typically pay back the investment in less than a year," adds Schurmann. ■

Lowering Energy Bills

Danfoss' solution can save up to 50% of energy in supermarkets…

Harmonising
Comfort, Capital And Environment

A healthy and cool indoor climate is a basic living right in the dynamic Middle Eastern region. Facility owners and managers make it a prime objective to guarantee this key necessity for their residents. Large investments in (often complex-cooling) networks are required to fit the purpose of providing long lasting and energy efficient cooling solutions...

As building owners and operators strive to deliver on their promise of a healthy and comfortable living to their residents, often just after the first years of operation, they start to experience serious shortcomings of the systems.The cold surfaces of the – often underperforming or damaged insulation – cold distribution systems attract the moisture from the air, causing condensation. In dryer climates, moisture is mainly caused by occupants themselves; cooking, cleaning, transpiration and exhalation. Combined with the insulation material that absorbs the moisture, it develops an ideal feeding ground for bacteria, growing numerous types of moulds. Mouldy ductwork can cause serious risks. Common complaints from occupants are coughing, shortness of breath, irritated eyes and dizziness. At some point, the condensation will also start dripping down, causing stains and further formation of moulds in ceiling and walls. As many insulation materials also soak up the condensate, it will lose its insulation value and will start to absorb the cold energy from the carrier pipes and ducts. As the cooling system needs to make up for the cold that is subtracted from the system, it will consume more energy to maintain the right flow temperature throughout the network. In case the carrier pipes are made of steel, the wet insulation will also cause corrosion. Within no time, the network will show leakages, catalysing the aforementioned effects. Soon the first pipe bursts start to show – and the system, or parts of it, needs temporary shutdowns to conduct the necessary repairs. It goes without saying that this leads to serious headaches, both for cost of ownership and, most importantly, occupant comfort.

As these kinds of scenarios unroll, operational costs can develop exponentially.

The cold losses throughout the system need to be compensated by the chiller installation and increasing pump capacity, in both cases energy costs start to rise, leading to higher bills. Sometimes even extra investments are needed to install cooling capacity to keep up with demand.

To limit the effects of condensation, investments need to be made to take measures in containing the forthcoming problems; air filters, intakes,de-humidifiers, and dampers need to be installed. To prevent mould from spreading, additional maintenance is required. As the system starts to degrade, repair expenses start to overtake maintenance costs.

Engineers are aware of these risks, and anticipate them by including additional safety margins leading up to 25% overdesign of the installations; ducting, piping and chillers. Not to mention residents' complaints, claims and the eventual loss of business forowners.

Much aware of these problems, facility owners, managers and consultants search for reliable, yet simple solutions, so they guarantee a secure supply for a minimal total cost of ownership. That way they can ensure customer satisfaction throughout the entire operation time of their buildings. As they want to provide a healthy indoor environment to their valued customers, they need healthy materials inside the building.

Innovations have been developed to mitigate the aforementioned risks. Often able to prevent some of the problems, it also often means making compromises on other aspects; such as investment costs, the ecological footprint or the use of healthy and recyclable materials.

The bigger picture

Global threats to our societies including climate change, resource scarcity and ecosystem health are on the rise. Cooling is one of the most intensive forms of consumers of energy, as the demand is often 24/7 and 365 days a year. Adding up the increasing demand for cooling, due to increasing population, rising temperature and humidity levels, one can conclude that cooling is a precious form of energy that should be handled with care. Reducing the ecological footprint and minimising the depletion of resources - this serves as the common objective throughout the value chain.

For that, we need to take a close look at the solutions that are out there. Energy infrastructure plays a key role in maximising our use of energy, and make scarce resources meet future demands. That requires transition to innovative, smart energy systems that are both simple, yet highly cost-effective and can deliver a sustainable performance throughout a long lifetime. Especially when it comes to cooling, traditional systems simply don't cut it.

That is why more and more investors, contractors, and building owners in the HVAC market look for healthier and more resilient answers for their energy needs, especially when it comes to cooling. At the same time, whether replacing old systems in existing buildings, or installing systems in new buildings, tight time schedules need to be kept to maximize occupation time. This requires systems that are also fast and easy to install so that downtime can be kept to a minimum.

Look before you leap

Many may not be aware of it, but the solutions that can offer this solace are already available. We just need to take a good look around. This relates to both the design of cooling systems as well as the materials that base them. Take carrier pipes for example; polybutylene (PB) by far outperforms its metal, PEX and PVC counterparts. It completely eliminates any risk of corrosion, and offers superior resistance to stress, sound and mechanical influences over a much longer lifetime – in most cases even up to 50 years. As it is flexible, much fewer joints are needed compared to rigid, reducing the risk of leakages and pressure losses, while cutting both the installation time and labour needed up to 40%. This crucial value is further ensured by the light weight and easy, homogenous weldability of PB.

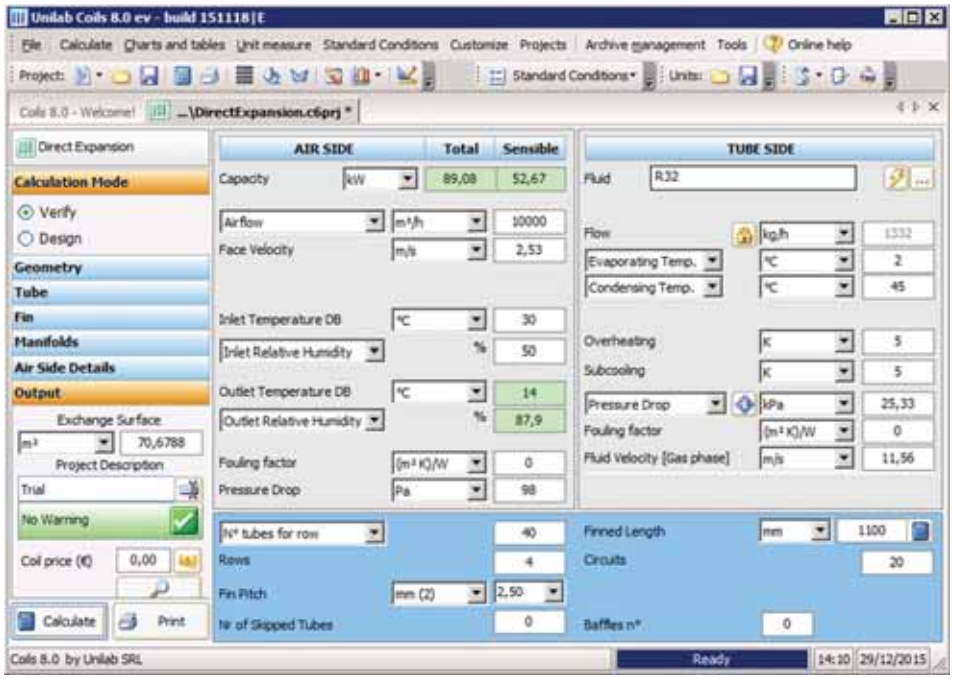
Flexible polyolefines provide an ideal suitability for insulation applications too. The closed-cell structure and other characteristics of polyethylene (PE) foam insulation results in very high water vapour resistance. Which in its turn leads to the long term defence against condensation – and makes a vital contribution to raising occupant comfort, while greatly lowering energy bills and environmental impact. PE insulation can also live, and probably outlive, the lifetime of the building that it serves. Both PB and PE are circular materials, and can be completely recycled to serve their original purpose.

When it comes to district and group networks, pre-insulated piping systems and innovative network design can greatly increase installation ease and speed along with system performance by using much longer lengths of pipes on coils. This minimises the number of joints and the risk of leakages so that network lifetime is maximised – securing comfort for current, and future users.

Healthy materials make for a healthy environment, both indoor as well as in the world around us. Smart, and sustainable systems can tap an immense saving potential while at the same time securing a reliable supply, minimising the total cost of ownership of what are often experienced as costly ventures when it comes to cooling. Yet with the right cooling solutions,comfort, capital and environment fortunately need not be a compromise. ■

Sandeep Mendiratta
Country Manager – India
& Business Development
Head – MEA
Thermaflex Insulation Asia
Co. Ltd.

Calculation Of PERFORMANCE



R32 is considered by many a safe, cost-effective and efficient refrigerant with a low environmental impact, this article talks about how to calculate an R32 dx finned pack heat exchanger...

Throughout the history of Air Conditioning and Refrigeration, many substances have been used as refrigerants. However, previous generations of chlorofluorocarbons refrigerants (CFCs) and hydrochlorofluorocarbons refrigerants (HCFCs), have contributed to the depletion of the ozone layer and are now in phase-out due to international treaties. CFCs and HCFCs have been replaced largely with hydrofluorocarbons (HFCs). Some of these HFCs have high levels of global warming potential (GWP) and their use is becoming subjected to restrictions. Recently, in order to reduce GWP, refrigerants denominated HFOs (hydro-fluoro-olefins) and HFOs have been introduced.

They have zero as reduction Ozone depletion potential (ODP) and a very low GWP, but some of them are flammable.

In some countries, CFCs are already banned, in others their use is limited and declining.

Currently, allowed refrigerants are natural gasses, HFCs, HFOs, and mixtures of these refrigerants.

HFCs R404A and R507A refrigerants are mainly used in commercial refrigeration for freezing and storage. They replaced the (HCFCs) R22 and R502, both harmful to the ozone, after the application of the Montreal Protocol. However, their values of GWP are still very high, and their use is declining.

There are many mixtures proposed as a possible replacement. These mixtures are composed of HFCs refrigerants: R32, R125, R152a and R134a and HFOs refrigerants: R1234yf R1234ze (E).

Other possible replacements for commonly used refrigerants with a high GWP are:

R134a replacements	
Fluid	**GWP**
R600a	3
R1234yf	4
R1234ze(E)	6
R744	1

R404A replacements	
Fluid	**GWP**
L-40	285
DR-7	246
N40	1205
DR-33	1410

How to calculate an R32 DX finned pack heat exchanger with UNILAB COILS

Since R32 is considered by many a safe, cost-effective and efficient refrigerant with a low environmental impact, we will perform the calculation of the performances of a finned pack heat exchanger using this particular refrigerant.

Benefits of using UNILAB COILS SOFTWARE over manual calculation

Performing the design or rating of a heat exchanger can be quite tedious and repetitive. Calculation steps involve complex equations and small errors and rounds might amplify the global tolerance of the calculation. Plus, if all this process has to be repeated quite a few times to find an efficient and cost-effective heat exchanger, then the whole process becomes way more time-consuming. But fortunately, there are many heat exchangers design software that help engineers in performing design and ratings efficiently.

UNILAB COILS (www.unilab.eu) is the result of 30 years of engineering know-how in the heat exchangers calculation field.

It allows engineers design and rate finned heat exchangers in the following calculation modalities:

- Heating and Cooling of the air without any change of phase of the liquid, gas or refrigerant in the tubes.
- Condensing and Direct Expansion of refrigerants, with a change of phase.
- Steam.
- Pump evaporators with R717.

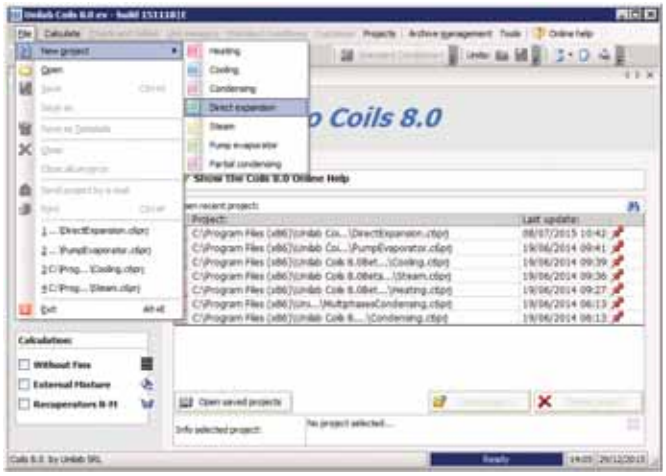
UNILAB COILS come with a large library of fluids and refrigerants (more than one thousand) including R32, R134a, R410A, R407C, R22, etc., and all the most modern refrigerants in the international market. This is a big advantage for further expansion of manufacturer's business outreach.

Not limited to that, UNILAB COILS incorporates an extensible archive of the most largely used geometries in the Air Conditioning and Refrigeration Industry. But what makes the software truly unique is the fact that you can simulate your own geometries, and compare capacity and air pressure drop results between geometries. These are some of the parameters that can be customized while adding or modifying a geometry: tubes diameter, tubes spacing, rows spacing, tubes displacement (staggered or aligned), spheroidal or integral fins, corrugation factor of the tubes and the fins (smooth, corrugated, pyramidal, windowed, louvered).

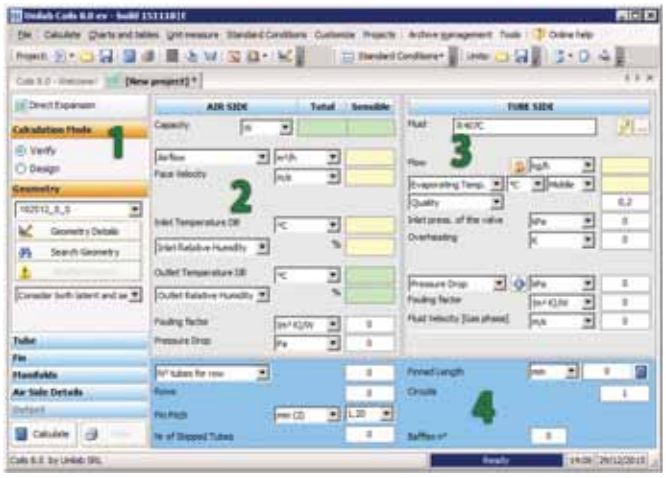
Finally, UNILAB COILS is a very easy to use software. For example, to calculate an R32 Direct Expansion finned pack heat exchanger, the procedure is quite straightforward. Let's see it in details.

Performing the R32 DX calculation with UNILAB COILS

First of all, we create a new blank project. From the 'Files' menu we select 'New Project' and then 'Direct Expansion':

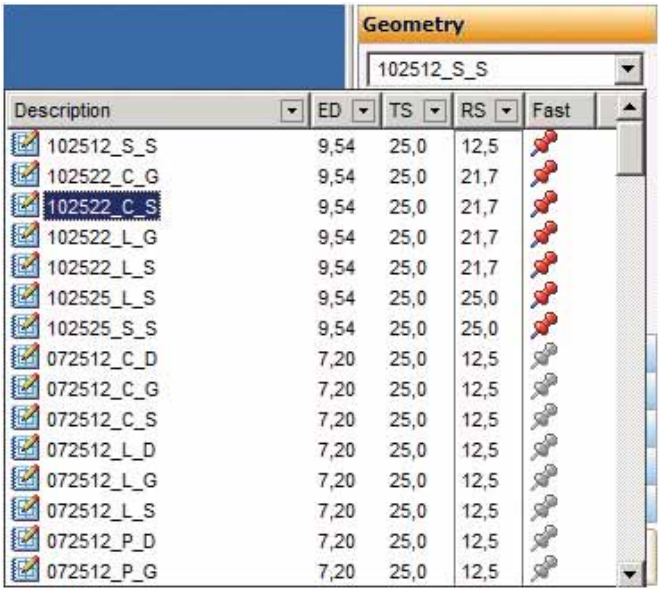


A blank project window will appear as:

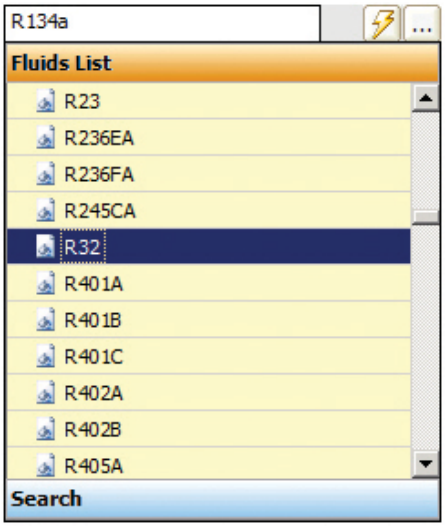


Where We can see four main areas:

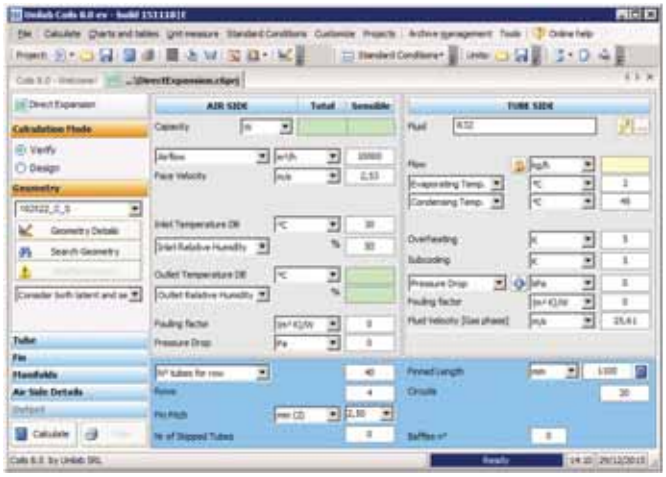
- Calculation type and relative Geometry – Tube data
  Fin data
  Manifolds Data
  and Air Side details
- Air Side data with related parameters
- Tubes Side data and related parameters
- Coils dimensional parameters



First of all, let's select the right geometry.

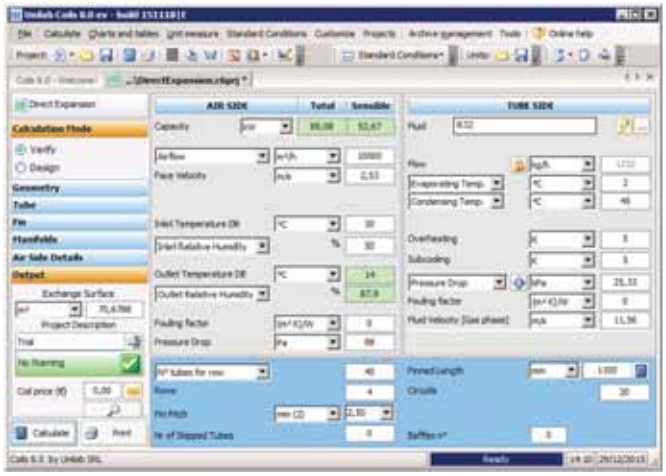


Details of the geometry can be seen in the next screenshot.
And the R32 fluid:



Now we fill in all the other parameters of coils constructive parameters.

Now that all the parameters have been inserted, let's perform the calculation by simply clicking on the 'Calculate' button.

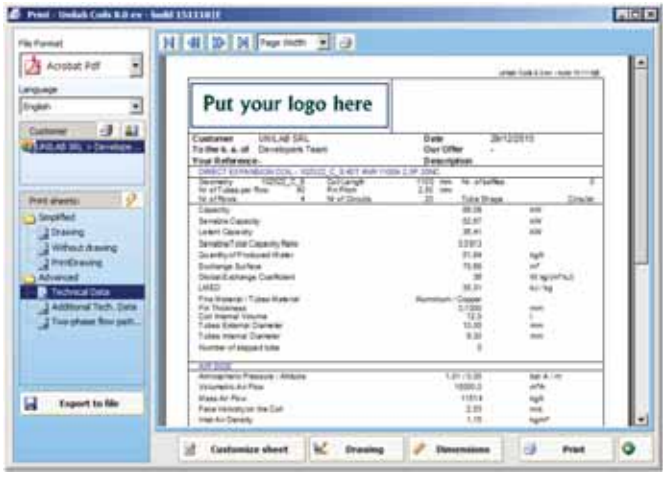


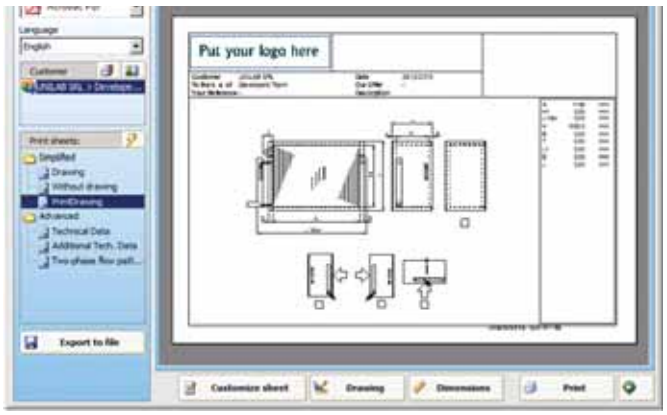
The software will calculate coil's performances, pressure drops, and many other parameters:

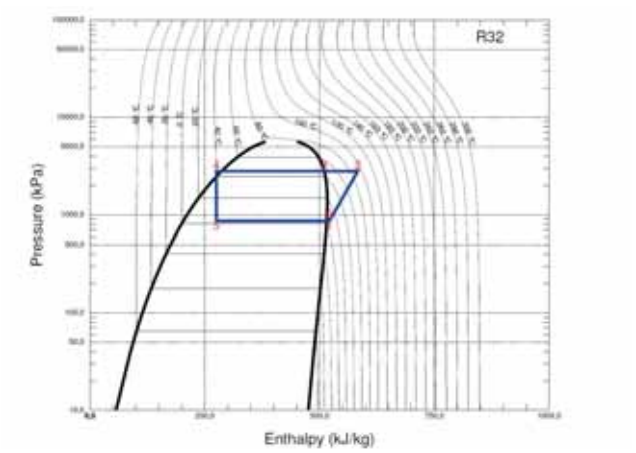
In UNILAB COILS, we can also export print-out pages with all the results in PDF, Word and straight to the printer.

The printout can also show a draft of the coil CAD drawing too:

This to show how simple it is to calculate an R32 Direct Expansion coil with UNILAB COILS.







Advanced feature

In the next portion, there is a representation of the above example's frigorific cycle on the P-H chart, directly plotted by UNILAB COILS.

This and many other features can be found in our 'Enterprise Edition' that carries a complete set of functionalities for the design and rating of Finned Pack heat exchangers. ■

Luca Martella
Sales & Marketing Director
UNILAB

Managing Legionella In Hospital

Legionella, often found in cooling towers and HVAC systems, associates with biofilm, a gelatinous layer consisting of microbial cells, the polysaccharide biopolymer they produce and debris extracted from the recirculating water…

One of the largest and most well-respected teaching hospitals in Illinois is also home to a central power plant with 7,000 tons of cooling tower capacity and a 100,000-gal central chilled water loop.

The hospital contracted Earthwise Environmental to identify potential water and energy conservation management opportunities throughout its facilities, with the goal of reducing water and energy footprints.

When *Legionella pneumophila* or other *Legionella* species are introduced to a host as an aerosol, a type of pneumonia, legionellosis, can result. A severe form of legionellosis is known as Legionnaires' disease, a term coined in 1976.

Legionella pneumophila is a ubiquitous aquatic organism that thrives in warm environments (32°C to 45°C) and causes more than 90% of Legionnaires' disease cases in the United States. Cooling towers, showers, spas, pools, faucets and potable water systems that circulate contaminated water are capable of producing a potentially lethal aerosol.

Committed to providing its clients with safe, environmentally beneficial technologies, Earthwise Environmental installed a MIOX AE-4 onsite disinfection system in July 2011 to replace a 12.5% bulk liquid sodium hypochlorite system for the 3,000-ton cooling tower in the hospital's neurosurgery center.

Using an electrolytic process that generates disinfectant by passing a high amount of electrical current through a salt and water mixture, MIOX systems produce Mixed Oxidant Solution (MOS)—a dilute bleach solution of 0.4% hypochlorite and related oxidants that reduces or removes biofilm, reduces algae loading and demonstrates a better free available chlorine (FAC) residual for maintaining cooling tower disinfection.

Traditional chlorine-based disinfection methods can pose a variety of safety concerns to the operator. Commonly used industrial-strength sodium hypochlorite (bleach) is caustic at a standard 12.5% solution.

Onsite generation systems use only water and salt and produce nontoxic, noncaustic oxidant solutions with a chlorine content that typically contains less than 0.8% FAC. These systems typically face less oversight from state health agencies, require less safety training for operators and have fewer insurance liability issues.

In addition, onsite generation is a more sustainable option compared to traditional chlorination methods. Transporting salt instead of chemicals to the hospital reduces carbon emissions: It can take more than four deliveries of 12.5% sodium hypochlorite solution to produce the same amount of chlorine as one delivery of salt.

The operating engineer observed that the cooling tower is visibly cleaner now and that the slime and live green algae are gone from the hot distribution decks. Storage and handling of hazardous chemical bleach have been eliminated, and the hospital's biocide program is more effective and efficient. ■

Interview

"Our field team members are one of the main sources of inspiration"

Sam Products Pvt. Ltd. specialises in the fabrication and export of a wide array of Clean Rooms, Air Shower, Pass Box, Air Curtains, Laminar Flow Benches, Clean Room Garment Cubicle, Air Cooling Systems, Module etc. In an e-interview with P K Chatterjee of Cooling India, Sanjay Batra, Director of the company is describing the latest challenges in Clean Room design and explaining their innovative solutions. Excerpts...

How is the Indian market for Clean Rooms and their components shaping up?

Market for Clean Rooms in India is increasing day in and day out. With increase in individual requirements the market for each and every product is bound to increase thereby increasing the Shop Floor Areas, in turn increasing the Clean Room requirements.

The increased awareness along with regulatory attention and the frequent production of higher value products are key drivers of advances for Clean Room technologies.

The shift in pharmaceutical and biotechnology industry from big molecule drugs to smaller and more flexible manufacturing facility for regional market requirements increases the Clean Room requirements. Targeted therapies, wide range of smaller volumes and niche products are the new trend setters for newer Clean Rooms.

Pharmaceutical including Safety Labs, Animal Supply Facility etc., themselves are expected to add more than 5% Growth Rate to the Clean Room Industry.

Safety of Working Personnal, Environment & Recent Focus for Safety of Healthcare Products has led to Product Innovation and Automation of Clean Rooms.

How is the opportunity in the international arena?

particle control is a global requirement. With the opening of new markets in India and in line with the Prime Minister's 'Make in India' dream, the opportunity in India has left the global market far behind.

As a manufacturer of Clean Rooms, what are the areas where you feel maximum focus is needed?

As a manufacturer in India for Clean Rooms, probably focus is required to see Clean Room as an industry in itself. Clean Room is a combination of:

a. Construction (includes Walls/ Terminals/ Cabinets/ Pass Thrus…)
b. Equipment (includes Heating & Ventilation Systems, Filters Laminar Air Flows…)
c. Consumables (includes Cleaning Materials..).
   – Incentives on development of new products suitable for Indian ambient conditions.
   – Simpler and clearer laws governing particle count.

As a manufacturer in India for Clean Rooms, probably focus is required to see Clean Room as an industry in itself...

What are the main challenges in contamination control?

a. The selection of construction materials should be made on the basis of durability, whether the material's surfaces can be cleaned and sanitized and how easy it is to do so, resistance to chemicals, and location.

   Construction materials come in two basic types, hard shell and soft shell. Soft-shell (flexible, plastic materials) Clean Rooms are not as durable as hard- shell Clean Rooms and have surfaces that are usually more difficult to clean and sanitize; therefore, they should be considered only for temporary purposes.

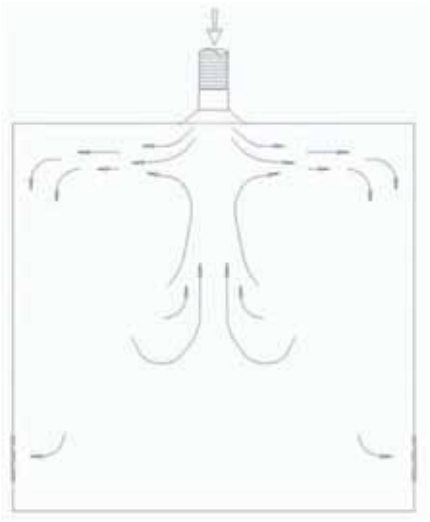
b. Typical specifications for defining a hard-shell Clean Room are as follows:
   1. Walls may be modular, having locking panels with all joints sealed or epoxy-coated wallboard. All coverings and sealing materials shall be resistant to cleaning and sanitizing agents.
   2. The wall panels will be extruded aluminium grid sections with honeycomb core of varying thickness (from 6 mm to 50 mm), which will be of modular construction. These wall panels will be of zero out-gassing type, either anodized or powder epoxy coated finish.
   3. The walls and ceiling must have smooth, cleanable surfaces. The interface with the floor and ceiling should be sealed with–approved materials and coved to facilitate cleaning.
   4. Raised flooring can be of die-cast aluminium tiles with perforations for the return passage, installed over a grid work of robust die-cast aluminium pedestals. All the utility and service pipes can be brought into the Clean Room through these flooring tiles at pre-determined locations. Heavy equipment can also be installed over these flooring tiles at predetermined locations with adequate passage for the return air movement. The floor void beneath the raised floor will act as the return air plenum and has to be designed as a Clean Room floor.
   5. Where return is drawn from lower floor levels, the floor shall be covered with sheet vinyl that is heat sealed or thin-set epoxy resin. The floor surface shall be seamless and cleanable. All coverings and sealing materials shall be resistant to cleaning and sanitizing agents. Materials should be FDA and USDA approved.
   6. The ceiling grids are of extruded aluminium, either anodized or powder coated, which can be ceiling suspended and firmly fixed on to the side walls. The ceiling grids will have built in recesses for light fixtures and terminal filters. The liquid gel sealant will make all the joints perfectly leak right. Commercially available ceiling grids consume approximately 18% of ceiling as dead zone as attic.
   7. Architectural details, such as windows, doors, pass-through, and utility penetrations, shall be as ledge free as possible. Window and door frames are to be constructed with double panes and flush frames.
   8. The ceiling shall be constructed of epoxy-coated gypsum board or in-laid panels. If the inlaid panel option is chosen, the panels must be impregnated with material that makes them impervious and hydrophobic. Panels are to be sealed or gasketed to the frame and tied down. The frame materials of construction shall be epoxy coated or anodized.
   9. Ceiling penetrations are to meet the following requirements: (a) sprinklers should be flush mounted, (b) lighting fixtures should be flush mounted, with smooth, sealed, airtight, exterior-mounted lens surfaces, and (c) utility penetrations are to be caulked or sealed with approved materials.
   10. The Clean Room design should contain a pass-through for materials entering the room from the anteroom. This reduces the potential for contamination by lessening traffic between the two rooms.
   11. Lighting fixture for the Class 100 and better Clean Rooms, shall be tear-drop type or flush mounting type (recess type), which can be made leak tight with liquid sealant. Flame-proof and explosion-proof type light fixtures are also available, which are wall mounting type, because of their size and weight.

What kinds of tests are conducted for Clean Rooms and their components?

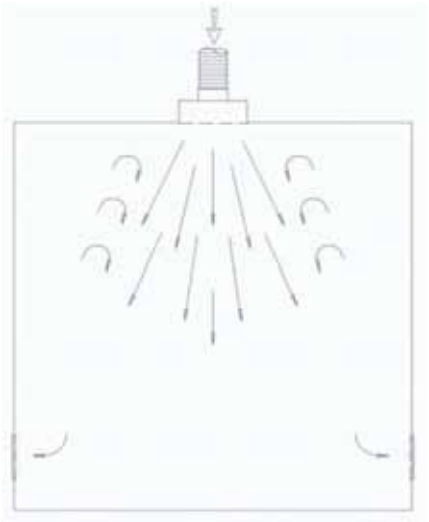
Recommendations for Clean Room include:

1. Only authorized personnel should enter the Clean Rooms. Nobody should be allowed into the Clean Room without wearing Clean Room garments including cap and Clean Room shoes.
2. Always stay in the 'air shower' for a specified time before entering Clean Rooms.

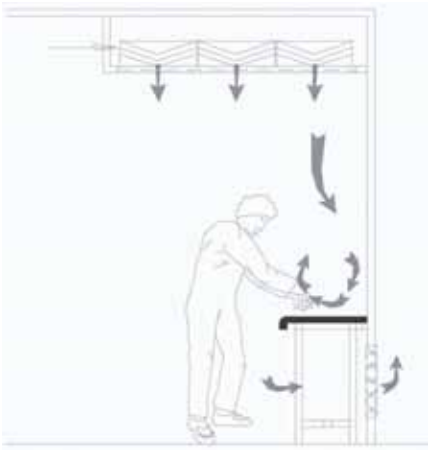
Induction diffuser (not recommended)

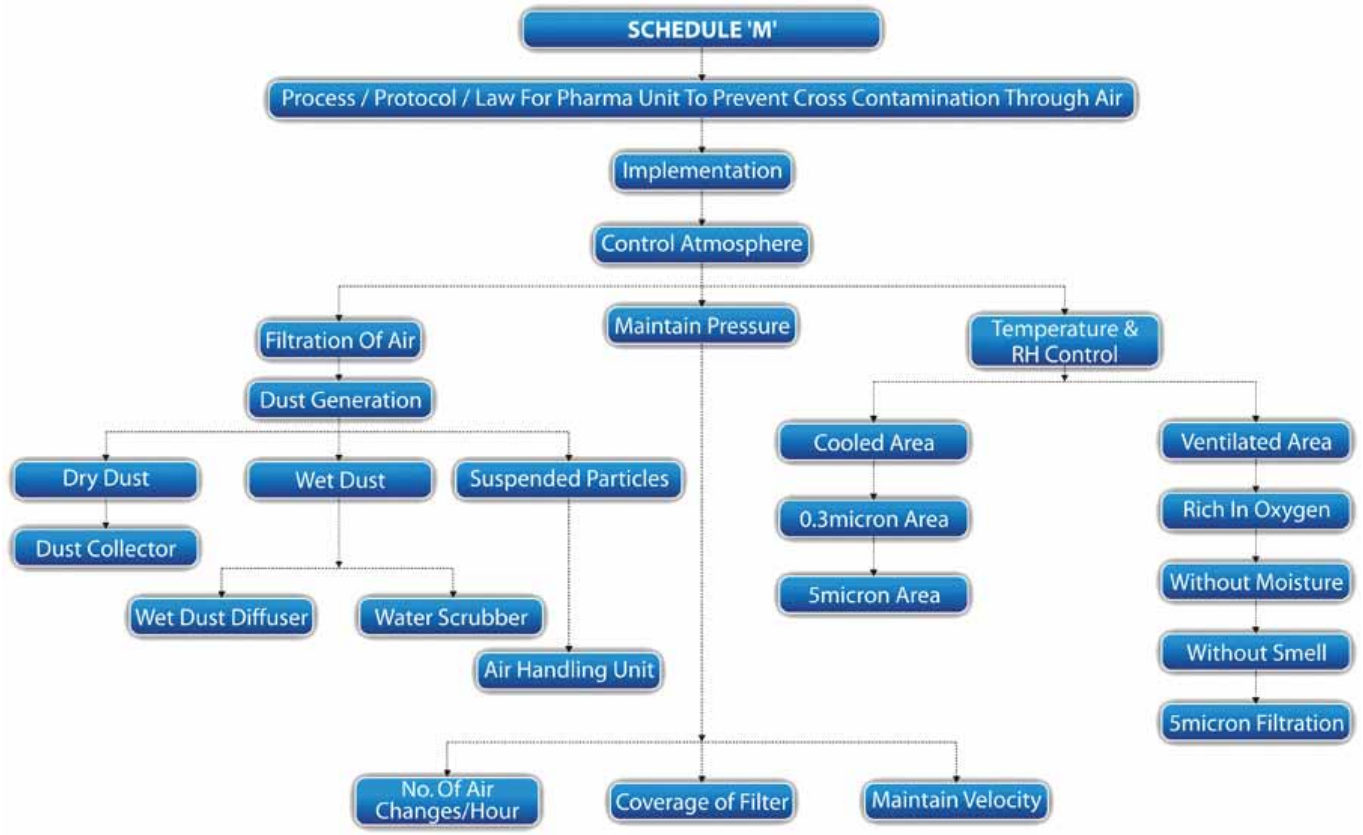


Perforated plate diffuser (recommended)



Operator subject to powder inhalation due to worktop obstruction





3. After the use of garments and shoes, these used Clean Room attire should be kept at a properly designated place. Never go into 'non-clean' areas from change room with garments or shoes.
4. Do not walk into a Clean Room unless necessary.
5. Do not take contamination producing materials like tobacco, food, match boxes, purses, cosmetics, card boards and unnecessary papers inside the clean areas. Also, do not apply cosmetics in the clean area.
6. Do not sharpen pencils in the Clean Room and use a ball point pen only.
7. Wear gloves and finger cots whenever required.
8. Do not touch contaminated articles or surfaces after wearing finger cots/ gloves.
9. Do not scratch your head or rub your nails inside the Clean Room or change room and keep finger nails clean.
10. Do not take personal items into Clean Room, keep them in lockers provided.
11. Keep your work table clean.
12. Clean / change filters in the air conditioning system as and when required.
13. Never sweep the Clean Room floor, vacuum them or wet mop

Clean Room Poster

I designed this poster for a Silicon Valley company. They had many employees who were from other countries with poor English Skills, So, they needed a visual way to communicate to these workers how to prepare for the Clean Room.
This poster improved compliance drastically.

them as per frequency specified.

14. Clean walls, ceilings and furniture as per frequency specified with wet mop.
15. Garments should be washed as per frequency specified.
16. Clean all furniture, equipment and raw material packages etc. properly before taking into Clean Room.
17. Do minimum maintenance of equipment inside the Clean Room. Take the equipment outside the Clean Room for maintenance.
18. Unpacking of the machinery required for the clean areas should be done outside the Clean Room.

How meticulously do you focus on Research & Development (R&D)?

Our field team members are one of the main sources of inspiration for feed back and product improvement.

Every sixth product inherits a new change.

Our focus remains on product improvement and end user satisfaction.

Apart from the Long Tunnel Type Air Showers, we have developed New Product (Work Bench) for Blood Bank. Here the Work Bench has Controlled Temperature on the Surface to maintain Good Quality of RBC & WBC. The Room Temperature could vary from 21°C to 30°C, while the Temperature required for Good Quality Blood Storage is 4°C to 8°C.

Another feather in our cap is the Door Interlock System for Rooms under various Air Pressures connected to BMS and suitable for Operators returning from Hazardous Conditions.

This year our team members also developed Special Garment Storages Cabinet suitable for Disposal of Garments used in Highly Infectious Pathogens.

Please tell me about some of your significant in-house developments through R&D.

One of our clients discussed a problem with us during one of our visits. The product is lead based. Lead being in powder form floats in the air and settles on the operator's dress while working at the shop floor. Thus, while having his meals at the canteen, the lead dust would fall on his meals and the same would be consumed by him.

Our team developed a new air shower wherein we delivered 45m/s of air at the nozzles.

> We probably have made the longest air shower (25 feet) of stainless steel sheet 304 grade, in the country...

We probably ended up making the longest air shower (25 feet) in the country of stainless steel sheet 304 grade. The high turbulence of air in the walkway assisted to reduce the lead content on the operator's dress. The air shower was placed after the shop floor and before entry to the canteen.

The reduction of lead was huge, even the operators were happy with the results. The new development assisted in a big way, saving precious human lives.

What are your short-term future plans?

We at SAM PRODUCTS are preparing for the 'Make in India' challenge. Increase in Production Floor Space, Add New Machines, Technology Transfer, May be a Joint Venture, Hiring More Skilled Staff.

We are already adding more products to our list of Items. ■

Improving
Performance And Safety

When plant becomes old say around 3 to 4 years, actual energy consumption becomes more evident...

Refrigeration systems are widely installed in India more than 60 years now. We have developed knowhow and technology to manufacture refrigeration equipments in India. We also have design, engineering, installation and commissioning knowledge for refrigeration system.

India is widely using Ammonia – a natural refrigerant for more than 60 years. We have lots of refrigeration system – for example: installed refrigeration system for cold storages and food processing industry, which are more than 20-30 years old. They were designed and installed with technology available during those years.

Initially when a plant is new, we may not get clear picture about plant performance, energy consumption and safety. When the plant becomes old – say around 3 to 4 years, actual energy consumption becomes more evident. More thrust is given to production / maintenance of temperature, rather than plant performance and safety. This results into deterioration of plant performance, more energy consumption, increase in running hours of compressors and increasing cases of breakdown than initial stages along with increase in operating cost.

As a plant owner, we must ask the following questions to ourselves:

- I already have an existing plant and I need to know the following:
- Whether my plant is optimized?
- I have already modified my plant to get better performance, but am I getting that?
- Is my plant energy efficient?
- Is may plant safe and easy to operate?
- Whenever I visit the refrigeration plant room, I smell ammonia.
- Is my maintenance cost increasing day by day?
- Are breakdowns increasing?
- Is always any one of the equipment under breakdown?

One must start asking the above questions and take suitable action accordingly.

Once we start asking these questions, then it consider this as a first step for improving plant performance and safety.

In order to know the answer for the above such questions we suggest taking planned logical steps.

First thing is to form internal team: The members of the team must be fully motivated, ready to devote time – and are enthusiastic to take up this task.

Second step is to conduct external technical Audit: Even though our team is operating the plant day in and out – and has sufficient in-house expertise, it is recommended to appoint external agency to audit the plant. The external auditor carries out an unbiased study of the plant and that will help in achieving better end results and objectives.

Third step is – study the external report and take suitable actions to achieve the goal.

Before we start any of the activities, we must study the following Table 1. This table indicates approximate percentage of installed kW of major equipments in total refrigeration system in a low (-25 Deg C) room temperature cold storage.

Table 1: % of total refrigeration plant installed kW

Sr. No	Refrigeration Equipment	% of total refrigeration plant installed kW
1	Compressor	65%
2	ACU	21%
3	Condensers + jacket cooling pumps	11%
4	Ammonia pumps	3%
5	Total	100%

Keeping in view of the above let us see advantages of audit to improve the existing plant performance and increase safety of the plant.

1) Check existing basis of design and if required formulate proper revised basis of design of existing plant:

We must formulate existing plant basis of design if not available. During the years we might havemodified the plant or removed certain equipment or add more load to existing plant. It is always better to write down the present refrigeration load w.r.t respect to our installed plant refrigeration capacity.

2) Check existing plant operating parameters:

We must check and evaluate existing plant operating parameters such as evaporationtemperature / discharge pressure our plantas it directly affects the energy bill.

2.1) Effect of evaporation temperature on energy bill: If Cold room temp required is0 Deg C. The evaporation temperature to achieve this temperature should be -5 Deg C. If we observed that we are operating the plant say at -10 or -12 Deg C. This will directly results into higher electricity bill. We need to then find out and if required we have to rectify

the existing system so that our plant operates at desired evaporation temperature. The following table-2 will indicate effect of evaporation temperature on electrify bill.

Item	unit	-5 Deg C evp temp.	-10 Deg C evp temp	-12 Deg C evp temp.
Evaporation temp	° C	-5	-10	-12
Suction Pressure	kg/ cm^2 / PSI	2.62/ 38	1.97/ 28.95	1.73/ 25.43
Comp. capacity	TR	75.64	75.64	75.64
Shaft power	kW	69.08	80.7	85.11
Extra kW / hr if we operate at lower evp temp.	kW	----	11.62	16.03
No of hours per day operation	hr	---	18	18
No of days in year march to Nov.	days	----	270	270
Electricity cost / unit	Rs/ unit	----	7	7
Extra cost of electricity for 1 year	Rs	-----	3,95,312	5,45,340

Table -2 Effect of evaporation temperature on energy bill

Install properly designed system to control desired suction pressure. The payback period for such properly engineered and designed system will be approx. two years for positive temp system and approx. less than one year in case of low temp system.

2.2) Effect of discharge pressure on energy bill: Check at what discharge pressure the plant is operating w.r.t designed discharge pressure. Following Table -3 indicate effect of higher discharge pressure on energy bill.

Table 4: Following table indicates the energy saving achieved by replacing single stage compressor by two stage compressor for -30 Deg C evaporation temperature operations.

parameters	Single stage	Two stage
Evp/cond temp Deg C	-25/40	-25/40
Capacity kW	96.7	96.7
Shaft power kW	47.2	39.3
% energy saving		16.74%

Item	Unit	Discharge Pressure kg/cm^2 (g) @ 40 Deg C design condensing temp.		
Operating pressure	kW/PSI	12.34/ 181.4 (desired)	14.92/ 217.85	16.18/ 237.85
Comp. capacity	kW	80.26	80.26	80.26
Shaft power	kW	62.0	73.29	79.2
Shaft power Diff. /hr.	kW		11.29	17.2
No of hours per day operation	hr	---	18	18
No of days in year	days	----	360	360
Electricity cost / unit	Rs / Unit	----	7	7
Extra cost of electricity for 1 year	Rs / year	-----	5,12,115	7,80,192

Table -3 Effect of higher discharge pressure on energy bill.

The high discharge pressure can be due to non-condensable gases in the system.

The properly designed and installed system to remove non condensable gases has payback period less than one year.

3) Check installed equipment selection w.r.t our operating parameters and from energy saving point of view.

Evaluate major installed equipment like compressor, condenser, air cooling unit for their operating parameters and performance. Study the findings and advice given by the external auditor and take action as recommended. We give below some of the example in this regard.

3.1) Check selection of compressor w.r.t. required operating evaporation temperature:

For example: If it is observed that single stage compressor is installed to operate at -30 Deg C evaporation temperatures. If we replace this single stage compressor to two stage, we will achieve considerable energy saving. This is shown in Table -4 below.

Table: 4 Single stage v/s two stage compressors.

As per experience, the payback period for above replacement is less than six months.

3.2) Check performance of existing condenser and possibilities of any energy saving:

We give in Table: 5 comparisons of various types of condensers and energy saving possibilities in the same. Table: 5 comparisons of various condensers

4) Plant Automation:

Check whether automation is installed or not. Various automation levels can be incorporated based on plant type, skilled man power availability.

The recommended approach towards automation is as below:

- To reduce Human dependence on plant maintenance.

Item	Atmospheric	S & T / PHE	Evaporative
Hear rejection capacity (kW / TR)	700 / 199	700 / 199	700 / 199
Water flow rate required (cum /hr)	180.78	150.44	68.4
Water pump motor (kW)	15.0	11.0	3.7
Fan motor (kW)	---	5.5	6.6
Total installed (kW)	15	16.5	10.3
Saving in installed kW w.r.t Atm condenser		Nil	4.7
Saving in energy cost / year (4.7 kWh x 18 hr / day x 270days x 7 Rs/unit)			1,59,894
Capital cost	Coil less / Civil high	Moderate	High
Water quality maintenance	very important	very important	very important

- Automatic Parameters recording to avoid human error and intervention while recording.
- We should be able to monitor plant parameters any time and from anywhere.
- Automation to be developed to helpoperatorto operate plant at desired parameters and avoids excess energy consumption due to operator error.
- Operator frequently throttle valves installed at liquid Header (going to cold room) from plant room to avoid liquid stroke to compressor. Automation avoids this and operate can devote more time on more fruitful work than this.

Based on above it is recommended to evaluate the status of existing plant automation and follow the expert advice to develop automation to suit specific plant requirement.

5) Study plant safety point of view:

Study the safety interlock, ultrasonic test reports, pipe condition, support condition. Take action as recommended by the expert to make plant safe and easy to operate.

Next to this, we are giving some of the photographs of the plant before and after audit which made the plant safe to operate.

5.1) 35 year old receiver replaced by new – as old receiver as we observe that thickness of receiver was drastically bad – and it was unsafe to operate.

5.2) Proper cleanliness / Housekeeping maintained after audit for safe movement in case of emergency

Along with housekeeping, please check and evaluate whether receiver spray shower is working or not, all personal protective equipments are in proper condition or not, ammonia leak detection system is installed or not, if installed it is in operation or not. If any discrepancy is observed, then it is recommended to follow the expert's advice and comply with the same.

To conclude following are the points to remember:

- It is very much possible to achieve desired energy efficiency throughout the life of the existing plant.
- With proper guidance and SOP in place every year we can improve / maintain desired plant performance.
- Prepare preventive maintenance schedule and strictly follow to minimise breakdown.
- Analyse/ evaluate every year present operation properly to optimise the plant operation. This will help in increasing production, improve quality, improve performance and save energy.
- While replacement of equipment – Optimise Capex along with Opex.
- Any such modification for plant performance improvement does not cost high. Normally payback period is less than two years. ■

Anil D Gulanikar
Director
DAG-TECH-SERVICES

Lining Up New Products

LG unveiled new commercial AC products at ACREX INDIA 2016...

Seeking to make deeper inroads into the Indian market, LG Electronics (LG) has presented its full lineup of Commercial Air Conditioning (CAC) and energy solutions at ACREX India 2016.

LG's corrosion resistant MULTI V IV, the company's latest Variable Refrigerant Flow unit (VRF) integrates sophisticated new technologies that effectively minimise energy loss under partial load conditions, giving the air conditioner a superb Coefficient Of Performance (COP) rating of 4.79.

Meanwhile, the Ocean Black Fin Heat Exchanger's dual layered and double-sided coating shield the MULTI V IV from corrosives like salt, sand and other elements brought in by strong sea winds, and even industrial pollution. The Ocean Black Fin and Dual Protection coating's unique material and composition protect it against corrosion, which also improves the durability of the MULTI V IV.

Particularly well suited for high-rise HVAC applications, LG's fourth-generation inverter compressor gives the MULTI V Water IV the widest operational range in the industry with an impressive 5.5 COP (PHE type). The MULTI V Water IV also registers a superior integrated part load value (IPLV) of 6.73.

The model's operational efficiency has been improved via a range of intelligent functions, and installation is now easier than ever – thanks to the MULTI V Water IV's reduced dimensions and weight. LG's revolutionary HVAC incorporates a versatile Shell and Coil heat exchanger – which helps it maintain these lofty performance standards, even if it is connected to an impure water source.

Designed primarily for buildings that require a large, dependable supply of hot water, LG's Hydro Kit is well suited to a wide range of commercial and public sector applications.

LG's new product also provides considerable installation flexibility and an eco-friendly performance with fewer CO_2 emissions. The compact, modular design of the LG Hydro Kit translates to exceptional flexibility for architects and HVAC system designers. Installation options are further multiplied as no duct work is necessary for the expulsion of exhaust gas. The Hydro Kit's supreme versatility makes it suitable for a whole host of facilities, including hospitals and hotels. ■

MULTI V IV Product...

COOLING OPTIMISATION
FOR LARGE POWER CYCLES

The cold end optimisation of fossil fuel power generation cycles necessitates the maintaining of the return cooling water temperature to the condenser to its minimum value. It is generally seen that as the overall efficiency of the power generation cycle improves, the quantity of steam condensed decreases and the cooling water as well as the cooling load is reduced. This is one of the benefits of having the highest possible power generation cycle efficiency. The power generation cycle efficiency improves when the technology is changed to super critical and in the medium term to ultra supercritical and in the long term to advanced ultra supercritical cycles...

The large power cycles refer to Rankine type power generation cycles of capacity 660 MW, 800 MW and 1000 MW. Present cycles are either subcritical (SubC), super critical or ultra supercritical. The super critical and ultra super critical (SC/USC) are generally of very high cycle efficiencies as compared to the sub critical cycles and hence their heat losses are also lower.

Basically, as the energy efficiency of the power cycle increases the cooling water requirement, the auxiliary power and water make up all are reduced.

The change over from sub-critical to super critical and ultra supercritical power cycles results in considerable saving in cooling water requirements as well as power for circulating the cooling water. Improving the power cycle energy efficiency automatically improves the efficiency of the cooling water cycle.

The heat losses in a thermal power plant are:

- Dry and wet flue gas losses which exit the plant through the stack. These losses generally cannot be recovered though a few technologies are in vogue for reducing the losses.
- Heat losses in auxiliary power utilization system. The auxiliary power forms around 6-8 % of the maximum continuous rating of the unit (MCR).

  The auxiliary motor efficiency is around 92% with a thermal loss of 8%. Out of this only 1% of the loss is accounted for by heat generation in bearings and being cooled through the bearing cooling water. Hence, only 0.08% of the MCR power is being lost as bearing cooling loss. This is a negligible quantity as compared to the major loss in the turbine cycle.
- Heat generated in the operation of the generator. These are the generator cooling losses and represented by the heat carried away by hydrogen and the tertiary cooling water. The generator efficiency is quite high of the order of 98.6%. The heat losses are of the order of 1.1-1.2% of the MCR capacity. These losses are also quite low.
- Energy required to condenser the steam from saturated vapour or in the two phase region to saturated liquid. This is the largest loss of thermal energy in the Rankine type power cycles. This is almost two times in magnitude of the power generated in the plant.

The cooling technologies available for cooling of the steam being condensed in the condenser for large power generating cycles are:

- Natural draft cooling tower
- Forced draft cooling tower
- River/canal water cooling
- Sea water cooling

Normally for coastal plants sea water cooling is being adopted because of the availability of sea water. Sea water cooling has the disadvantage that the normal cupro-nickel tubing for the heat exchange between the steam and the water in the condenser needs to be changed to titanium tubing which is quite expensive and with poorer heat transfer coefficient.

Also tube leak with sea water can result in very serious corrosion issues in the boiler and turbine due to the carry over of the salinity in sea water into the high purity steam cycle feed water.

The detection systems for the Water purity has to be extremely efficient in rapid detection of leaks since it will take time for identification and plugging of leaking tube.

The forced draft cooling towers have additional power requirement for operation of the forced draft fans...

The parameters which affect the performance of these cooling technologies are:

- Quantum of water hold up required at the plant
- Quantum of water make up to compensate for permanent water losses due to evaporation, percolation, drift, etc.
- Auxiliary power for running the system

Results of study

The typical performance of the three types of plants are given in Table 1.

Sr.	Parameter	Unit	Sub C	SC	USC	Sub C	SC	USC	Sub C	SC	USC
1	Power output	MW	660	660	660	800	800	800	1000	1000	1000
2	Power input	MWt	1783.78	1609.76	1500.00	2162.16	1904.76	1818.18	2631.58	2380.95	2173.91
3	Boiler efficiency	%	88	90	91	89	91	91	89	91	91
4	Turbine heat rate	kcal/kWh	2012.7	1861.4	1753.7	2043.8	1841.0	1757.3	1994.1	1844.7	1684.3
5	Turbine efficiency	%	42.73	46.20	49.04	42.08	46.71	48.94	43.13	46.62	51.06
6	Generator efficiency	%	98.4	98.6	98.6	98.8	98.8	98.8	99	99	99
7	Gross overall efficiency	%	37	41	44	37	42	44	38	42	46
8	Auxiliary power in main cycle	% of MCR	8	6	6	7	6	6	6	5	5
9	Heat generated in boiler	MWt	214.05	160.98	135.00	237.84	171.43	163.64	289.47	214.29	195.65
10	Heat generated to bearing cooling	MWt	0.53	0.40	0.40	0.56	0.48	0.48	0.60	0.50	0.50
11	heat generated in generator	MWt	10.56	9.24	9.24	9.6	9.6	9.6	10	10	10
12	Heat generated in turbine cycle	MWt	854.05	740.44	660.85	1058.88	877.44	802.59	1265.40	1098.74	919.75

Table 1 The typical performance of the plants...

The theoretical cooling water flow required for cooling the turbine cycle is given in Table 2. Table 3 presents the conversion factors for the design and operating water requirements.

Sl. No.	Parameter	Unit	Sub C	SC	USC	Sub C	SC	USC	Sub C	SC	USC
1	Power output	MW	660	660	660	800	800	800	1000	1000	1000
2	Heat generated in turbine cycle	MWt	854.05	740.44	660.85	1058.88	877.44	802.59	1265.40	1098.74	919.75
3	Theoretical cooling rerquirement	water flow, t/h	20402.49	17688.46	15787.08	25295.68	20961.20	19173.13	30229.43	26247.91	21972.09

Table 2 The theortical cooling requirement...

The normal operating temperature difference (temperature gain in cooling water) is of the order of 10 °C.

However, the same can be reduced to 9 of 8 °C due to either poor condenser performance or higher inlet cooling water temperature [(lower terminal temperature difference (TTD)].

The theoretical water requirements for 660 MW, 800 MW and 1000 MW, sub critical, super critical and ultra supercritical plants is given in Figures 1-3.

The conversion factors for the design and operating water requirements are given in Table 3.

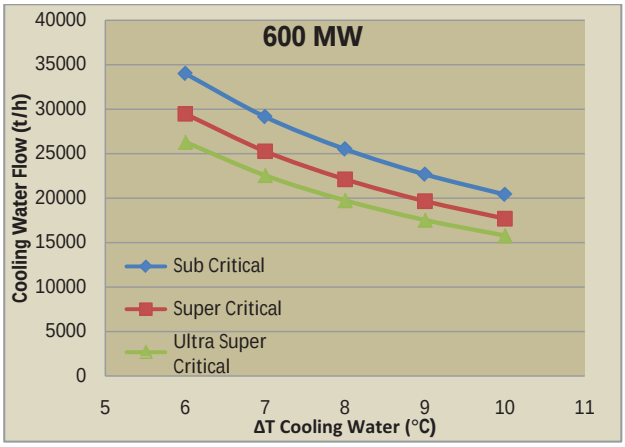


Figure 1: The theoretical water requirements for 660 MWsub critical, super critical and ultra supercritical plants...

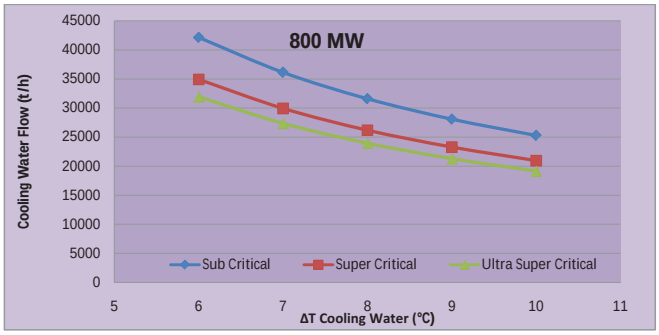


Figure 2: The theoretical water requirements for 800 MW for sub critical, super critical and ultrasupercritical plants...

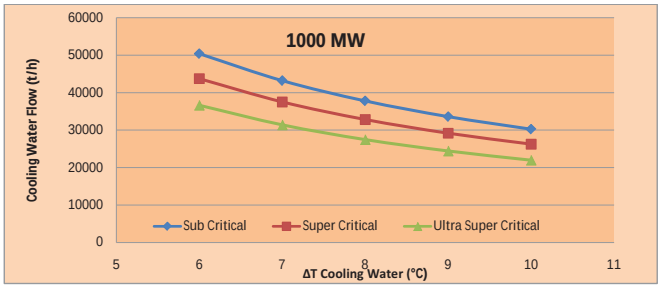


Figure 3: The theoretical water requirements for 1000 MW for sub critical, super critical and ultra supercritical plants...

Sl. No.	Parameter	Unit	Sub critical
1	Factor for differential temperature gain in cooling water	p.u.	1.67
2	Factor for pump sizing and redundancy	p.u.	1.67
3	Factor for design margin in CW pump motor	p.u.	1.20
	Total factor		3.35

Table 3 (above)...

The sensitivity of the cooling water requirement to energy efficiency of the plant is given in Figure 4.

The comparison of the four cooling technologies in terms of auxiliary power, water hold up, cooking water flow and make up are given in Table 5.

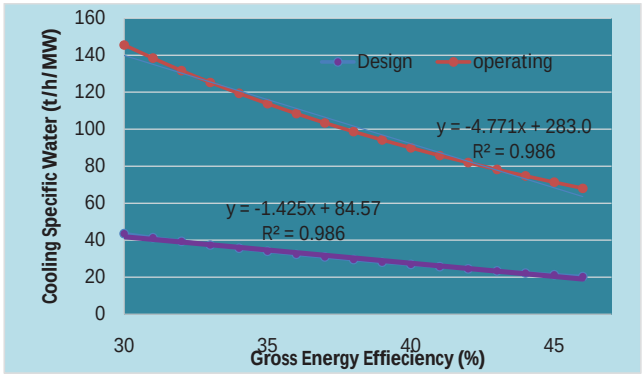


Figure 4: The sensitivity of the cooling water requirement to energy efficiency of the plant...

Typical design or operating water requirements for the, sub critical, super critical and ultra supercritical plants of 660 MW are given in Table 4.

Sl. No.	Parameter	Unit	Sub critical	Super critical	Ultra super critical
1	Power output	MW	660	660	660
2	Energy efficiency	%	37	41	44
3	Heat generated in turbine cycle	MWt	854.05	708.56	616.80
4	Cooling rerquirement	water flow, t/h	20402.49	16926.92	14734.95
5	design	t/h/MW	30.91	25.65	22.33
6		Factor for T	1.67	1.67	1.67
7		Factor for pump	1.67	1.67	1.67
8		factor for design margin	1.20	1.20	1.20
9		Total factor	3.35	3.35	3.35
10	design	t/h/MW	30.91	25.65	22.33
10	Operating	t/h/MW	103.46	85.83	74.72

Table 4:Typical design or operating water requirements for the , sub critical, super critical and ultra supercritical plants...

Table 5: The comparison of the four cooling technologies in terms of auxiliary power, water hold up, cooking water flow and make up...

Sl. No.	Particulars	AP (% of MCR)	Make up (%)	Cooling Water flow (t/h/MW) (*)	Cooling water hold up (t/MW) (*)
1	Natural draft cooling tower	1.3	3	103.46	0.43
2	Forced draft cooling tower	1.8	3	103.46	0.41
3	River/canal water cooling	1.3	0	103.46	0.10
4	Sea water cooling	1.3	0	103.46	0.10
	(*): 660 MW sub crritical plant				

Table 5: The comparison of the four cooling technologies...

Figure 6: View of a natural draft cooling tower in operation...

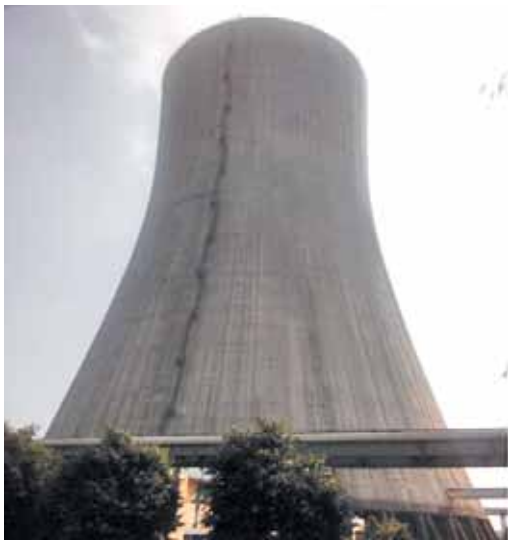


Figure 5: Typical view of a natural draft cooling tower...

Figure 7: View of air induction area of a natural draft cooling tower...

Figure 8: View of a forced draft cooling tower...

Figure 9: View of air induction area of a forced draft cooling tower...

Figure 10: View of a canal water cooling system...

Figure 11: View of a canal water cooling system...

Conclusions

- For inland power plants natural draft cooling towers are by far the best. The forced/induced draft cooling towers have an additional power requirement of 0.5 % of MCR for the fans.
- The drift losses in forced/induced draft cooling towers are slightly on the higher side but do not significantly affect the make up.
- Sea water cooling is ideal for coastal plants. However, the risk of contamination and the secondary damage leading to corrosion needs to be addressed by rapid detection and leak plugging technologies. ■

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A Case Study Of
Bhusari Cold Storage

A Rajendra Agriculture University study estimates post-harvest losses in horticultural crops at Rs.2000 crore per annum...

Bhusari Cold Storage Pvt Ltd is one of the several Rural Agri Business Centres (RABCs) in Bihar. RABCs have been seen as one of the significant interventions to accelerate growth of food processing sector in Bihar.

Bhusari Cold Storage has adopted rooftop solar and kickstarted the green energy adoption in the area of Begusarai, Bihar.

Background

Role of RABCs in Bihar

Bihar is the third largest producer of vegetables; fifth largest producer of fruits and eighth largest producer of grains in India. 90% of Bihar's population is dependent on agriculture.

Inspite of high volume of production and a good range of crops, the earnings from farming are poor.

A Rajendra Agriculture University study estimates post-harvest losses in horticultural crops at Rs.2000 crore per annum. The reasons for the post harvest losses are manifold. They include poor production practices, poor post harvest management practices, lack of grading at farm level, poor packaging, poor transportation, multiple handling, and poor marketing system.

Realizing the potential role horticulture can play in the development of the state economy, Government of Bihar has initiated the RABCs. Each RABC is expected to strengthen the agro economy in its catchment zone by providing the following services to the farmers and the industry - Sale of agri-inputs and services, Procurement and Primary processing, Storage, and Marketing.

Energy Scenario – Bhusari Cold Storage

Bhusari Cold Storage Pvt Ltd (BCS) is located in Begusarai district of Bihar. The cold storage facility has a capacity of 7200 MT and primarily used for horticultural products such as potatoes and onions.

Facilities also include farmers training for 20 farmers, 5 shops on agri input, and a soil testing lab.

As per its owner Mr Navneet, the key challenges the cold storage facility face are inadequate power supply and rising energy costs.

For a cold storage facility, average daily requirement of power would range from 320 kWh to 1200 kWh based on the facilities installed.

Taking into account the current power supply scenario in the state the facilities would run on DG set for approximately 4-8 hrs/ day.

Rationale for Rooftop Solar

When Mr Navneet Ranjan (promoter of BCS) pondered on the energy costs for facility, he realized that while his power cost from the grid (EB) were rising, his actual cost of power was much higher! This was because Bhusari Cold Storage was also using the power from the DG (Diesel Generation) set for approximately 6-8 hours a day.

The company evaluated alternative sources of energy. It was located in a remote location with plenty of sunlight and free rooftop space. BCS also wanted to ensure a reduced carbon footprint by minimizing its diesel usage. BCS realized that all these factors make rooftop solar power plant a commercially viable and compelling proposition to be implemented as a cost reduction initiative.

The company discussed with several companies and identified Fourth Partner Energy as their suitable partner for implementation of rooftop solar system in Begusarai.

Project Implementation

After site survey and initial design, Fourth Partner Energy (4PEL) proposed a 100 kWp Grid-connected Rooftop Solar System on the BCS premises. As per the site survey report, plenty of sunlight and shadow-free rooftop was beneficial to BCS. 4PEL customized the design to suit cold storage facility's rooftop area of 10,000 sq ft.

100 kWp Grid-Connected Rooftop Solar System (Side View)... As per the site survey report, plenty of sunlight and shadow-free rooftop was beneficial to BCS. 4PEL customized the design to suit cold storage facility's rooftop area of 10,000 sq ft...

The Roof Top Solar Photovoltaic Power Plant at Bhusari cold storage, Begusarai, utilised rooftop area of about 10,000 sq. ft available on the terrace and lift rooms of the building. The SPV power plant with capacity of 100kWp is connected to grid. No battery storage has been provided. It would meet partial load of the building during daytime.

The grid connected SPV project would be a demonstration plant to harness renewable energy and the data on generation would be utilized for analysis of the various aspects of operation as also that of availability of power.

Mr Navneet of BCS financed the project through a mix of debt and equity. Debt was financed through a PSU bank. While approving the project, the lending bank also considered 4PEL's credentials, system design and cost efficiency for the project.

100 kWp Grid-Connected Rooftop Solar System (Front View)... The grid connected SPV project would be a demonstration plant to harness renewable energy...

Key phases in the project execution included project design, system engineering, commissioning of plant, quality check, and O&M activities.

Work on the site lasted for 3 weeks for the 100 kWp Grid-connected Rooftop Solar System. As per the proposed design, no batteries were used.

The solar plant was commissioned in June 2015. Poly crystalline silicon modules were used for the rooftop installation.

BCS also received approval the SECI subsidy of 30% for its capital cost.

Project Benefits

The 100 kWp grid-connected rooftop solar system at Bhusari Cold Storage generates approximately 147,000 units (kWh) annually.

Savings in power bill during the first year are expected to be approximately INR 11 lacs and INR 465 lacs over the project lifetime (25 years).

The long life for the asset and low maintenance cost for solar ensures BCS some energy security for the next 25 years. Also, any excess energy generated can be exported to the grid.

The company can claim an accelerated depreciation of 80% in the first year – thereby reducing its tax considerably.

The expected payback period for the rooftop solar system is approximately 4 years.

The 100 kWp grid-connected rooftop solar system at Bhusari Cold Storage generates approximately 147,000 units (kWh) annually. Savings in power bill during the first year are expected to be approximately INR 11 lacs and INR 465 lacs over the project lifetime (25 years)...

Conclusions

For cold storage companies, power costs account for ~35% of the indirect costs.

By installing the 100 kWp grid-connected rooftop solar system, Bhusari Cold Storage has addressed two key concerns of the company:

- How to stem the rising energy costs
- How to reduce the carbon footprint and make a 'greener' world.

Environmental Impact by the company:

Implementing a 100 kWp system has the following environmental impact (per annum compared to coal fired thermal power plant):

- Emission reduction:
  COx ~ 1,30,000 kgs, SOx ~ 340 kgs, Nox ~ 340 kgs
- Reduction in usage of natural resources:
  Coal ~ 56,000kgs, Water ~ 2,43,000 lts
  This is equivalent to planting 5800 mature trees.

Installation Photographs

Mr Navneet of BCS financed the project through a mix of debt and equity. Debt was financed through a PSU bank. While approving the project, the lending bank also considered 4PEL's credentials, system design and cost efficiency for the project...

100 kWp Grid-Connected Rooftop Solar System...

About Fourth Partner Energy (4PEL)

Fourth Partner Energy Pvt. Ltd. (4PEL) aims to build, develop and manage a large operating portfolio of de-centralized solar power assets in India and is positioned as a leading RESCO (Renewable Energy Services Company).

Fourth Partner Energy (4PEL) started in 2010 with a focus on decentralised or rooftop solar energy market.

The company has completed over 400 solar installations across the country with several marquee clients. Customers range from a variety of industries such as educational institutions, corporates, hospitals, banks, industrial clients, and non-profit organisations. ■

Pavan Mallela
Marketing and Strategic Planning Initiatives
Fourth Partner Energy Pvt. Ltd. (4PEL)

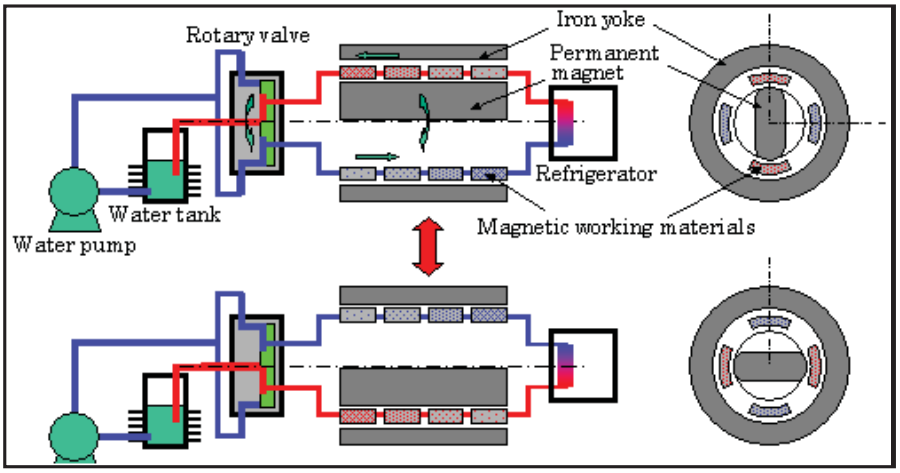
Magnetic Refrigeration Market To Grow

The market for magnetic refrigeration technology is expected to witness growth as it is more energy-efficient, uses no toxic or environmentally-harmful fluids...

The magnetic refrigeration market is expected to reach USD 315.7 Million by 2022, at a CAGR of 98.7% between 2017 and 2022. The industrial application is expected to witness the fastest growth owing to the growth of the food & beverage processing & storage segment. Freezers and refrigerators are expected to witness the fastest growth within the refrigeration segment.

Magnetic refrigeration is a cooling technology which applies the MagnEtocaloric Effect (MCE). The magnetic refrigeration technology does not involve the use of refrigerants and its Coefficient Of Performance (COP) is estimated to be higher than that of a conventional refrigeration system.

The market for the magnetic refrigeration technology is expected to witness growth as it is more energy-efficient, uses no toxic or environmentally-harmful fluids, has a compact design for portable applications, and entails a lower maintenance cost.



Magnetic refrigeration system configuration and operating flow...
Image Courtesy: Chubu Electric Co., Inc.

The magnetic refrigeration market has been segmented based on products (refrigeration, air conditioning, and heat pumps), applications (domestic, commercial, transportation and industrial) and geography.

The key players in the market include Cooltech Applications (France), Astronautics Corporation America (U.S.) and Camfridge Ltd (U.K.), General Electric (U.S.), and Whirlpool Corporation (U.S.) among others. ■

“The more you engage with customers, the things become clearer…”

Ensavior technologies Pvt. Ltd. is a comprehensive solutions provider company, engaged into design, engineering, sales, marketing and service of HVAC products, Plumbing products, Fire Fighting equipments, Ventilation & IAQ products and Acoustics-Noise-Vibration control products. In an e-interview with Cooling India, Dinesh Semwal, Managing Director of the company is focusing on the latest challenges in the Indian HVAC industry and their innovative products. Excerpts...

How is the Indian HVAC market shaping up?

Rise in infrastructure, rapid urbanization and growth in commercial properties are some of the key factors fuelling the market for HVAC systems in India. With healthy growth anticipated in the real estate sector, the country is expected to witness strong infrastructure development like metro rail etc., which would boost the market for HVAC systems over the next three to five years.

Growth in retail, hospitality and commercial sectors is significantly boosting the demand for such systems in the country, as these sectors involve large-scale application of HVAC systems in organized retail outlets, shopping complexes, hotels, etc. According to a study, the HVAC market in India is forecast to reach USD 4 billion by 2019.

What are the prominent trends here today? And how Ensavior, as a supplier find them fitting into the grooves?

The customer today is well aware of the latest things and realise the importance of energy efficiency and a better indoor environment. End users are trying to reduce their energy requirements and looking for ways and means to address consumption needs, there is a significant shift in the mindset of people to promote energy efficiency and improve indoor air quality. Therefore, energy efficiency and better indoor environment becomes a necessity more than a voluntary policy.

We at Ensavior promote the concepts and products that to a large extent address the issue of energy efficiency and indoor air quality. Our strategic tie ups with FTENE Korea, Xylem, Aeropure and recent addition of Flowcon International form a well mix of products that cater to the need of the hour.

How are you aligned with the vision of Smart Cities in India? And how much beneficial will be your products for this concept?

Indian government has announced the first 20 cities chosen from 98 cities shortlisted for the 'Smart Cities Mission'. The concept of Smart city is a gateway to adopt newer, reliable, energy efficient products. In fact one of our product/system is already being implemented at the first Smart City of India in Gujrat.

Our Chilled Water Thermal Energy Storage System together with energy efficient pumps and pressure independent valves from Flowcon International is well suited for these projects.

What kind of innovative products do you have for the Indian market?

Pumping: Ensavior brings Xylem pumping solutions, which are constantly developing and fielding new HVAC systems that work efficiently, making buildings more comfortable, productive and healthy. It provides energy efficient pumps, boosters, circulators, controls and other products and systems for building HVAC.

Hydronic Balancing: It is the process of optimising the distribution of water in a building's heating or cooling system – so it provides the intended indoor climate at optimum energy efficiency and minimal operating cost. We have joined hands with Flowcon, Denmark to provide the most efficient and most reliable hydronic balancing system.

Thermal Storage System: It helps lower Operational Costs by enabling the shifting of energy consumption of chillers from high cost hours to low cost hours by utilising stored energy during high cost periods and storing 'cooling' energy by running the chiller during low cost hours. Further, as lower capacity chillers may be used, the chiller can run at optimal capacity, thereby raising its efficiency level.

UVGI System: It leads to electrical energy savings to the tune of 10 to 15% by improving heat transfer efficiency of AHU cooling coil, which in turn results in reduction of chilled water requirement from the chiller. UVGI systems irradiate the AHU coils with UV-C rays, destroying the ability of the organisms to reproduce and multiply thus maintaining the indoor air quality of the air-conditioned spaces.

What kind of partnership support do you offer?

We engage on the project right from the conceptualisation stage and thereby help in right selection, optimum design and implementation of most energy efficient products. Besides that we ensure on site job trainings to project managers, facility managers and operators – so that the systems are operated in most efficient and simplest manner.

Based on need of the project, we also undertake operation and maintenance of the system – for which we have back up in terms of spare parts and manpower.

What is your mantra of success?

The more you engage with customers, the things become clearer, and it is easier to co-relate to his requirements. It is our constant endeavour to make every aspect of the customer requirement a little bit better, since we know when a customer comes first, the customer lasts. ■

In the recent attempts to stimulate alternative energy sources for heating and cooling of buildings, emphasis has been put on utilisation of the ambient energy from Ground Source Heat Pump Systems (GSHPs) and other renewable energy sources. Exploitation of renewable energy sources – and particularly ground heat in buildings can significantly contribute towards reducing dependency on fossil fuels...

Cooling And Heating **With Ground Source Heat Pumps**

A photograph showing the connection of DX GSHP installed at the School of Built Environment...

Renewable energy sources have one thing in common; they all existed before man appeared on this planet. Wind, wave, hydro, solar, geothermal and tidal power are all forces of nature and are mostly intermittent energy sources, geothermal is the only consistent phenomenon. Geothermal renewable energy sources where probably the first to be fully utilised by man. Early civilisations tapped this heat to cook, fire clay pottery, create baths and spas and even heat their homes. Roman villas had under floor heating from natural hot springs over 2000 years ago.

Shallow geothermal resources (<400 m depth by governmental definition in several countries) are omnipresent. Below 15-20 m depth, everything is geothermal. Figure 1 show a summary of the soil thermal properties. The temperature difference between the ground and the fluid in the ground heat exchanger drives the heat transfer – so it is important to determine the ground temperature. The temperature field is governed by terrestrial heat flow and the local ground thermal conductivity structure (groundwater flow). In some countries, all energy stored in form of heat beneath the earth's surface is per definition perceived as geothermal energy. The same approach is used in North America. The ubiquitous heat content of shallow resources can be made accessible either by extraction of groundwater, or more frequent, by artificial circulation like the Borehole Heat

Exchanger (BHE) system. This means, the heat extraction occurs–in most cases–by pure conduction; there is no formation fluids required. The most popular BHE heating system with one of more boreholes typically 50-200 m deep is a closed circuit, heat pump coupled system, ideally suited to supply heat to smaller, de-central objects like single family or multifamily dwellings (Figure 2). The heat exchangers (mostly double U-tube plastic pipes in grouted boreholes) work efficiently in nearly all kinds of geologic media (except in material with low thermal conductivity like dry sand or dry gravel). This means to tap the ground as a shallow heat source comprise:

- Ground water wells ('open' systems),
- Borehole Heat Exchangers (BHE),
- Horizontal heat exchanger pipes (including compact systems with trenches, spirals, etc.), and
- 'Geo-structures' (foundation piles equipped with heat exchangers).

A common feature of these ground-coupled systems is a heat pump, attached to a low-temperature heating system like floor panels/slab heating. They are all termed 'Ground-Source Heat Pumps' (GSHP) systems.

In general, these systems can be tailored in a highly flexible way to meet locally varying demands. Experimental and theoretical investigations (field measurement campaigns and numerical model simulations) have been conducted over several years to elaborate a solid base for the design and for performance evaluation of BHE systems. While in the 80s, theoretical thermal analysis of BHE systems prevailed in Sweden monitoring and simulation was done in Switzerland, and measurements of heat transport in the ground were made on a test site in Germany.

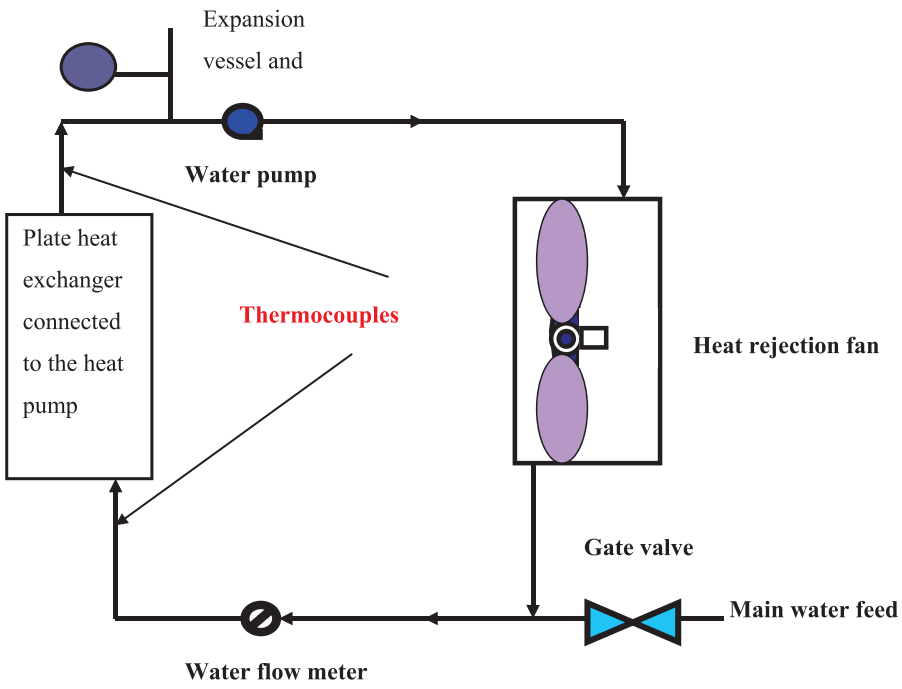


Figure 2: Typical application of a borehole heat exchanger (BHE) heat pump system in a central European home, typical BHE length = 100 m...

In the German test system at Schöffengrund-Schwalbach near Frankfurt/Main, a 50-m BHE was surrounded by a total of 9 monitoring boreholes at 2.5, 5 and 10 m distance, also 50 m deep. Temperatures in each hole and at the BHE itself were measured with 24 sensors at 2 m vertical distance, resulting in a total of 240 observation locations in the underground. This layout allowed investigating the temperature distribution in the vicinity of the BHE. The influence from the surface is visible in the uppermost approximately 10 m (Figure 1), as well as the temperature decrease around the BHE at the end of the heating season. Measurements from this system were used to validate a numerical model for convective and conductive heat transport in the ground. Starting in 1986, an extensive measurement campaign has been performed at a commercially delivered BHE installation in Elgg near Zurich. The object of the campaigns is a single, coaxial, 10 m long BHE in use since its installation in a single-family house. The BHE supplies a peak thermal power of about 70 W per m of length.

The ground temperature results are highly informative with respect to the long-term performance. Atmospheric influences are clearly visible in the depth range 0-15 m, and below 15 m, the geothermal heat flux dominates. The results show that in the near field around the BHE, the ground coils down in the first 2-3 years of operation. However, the temperature deficit decreases from year to year until a new stable thermal equilibrium is established between BHE and ground, at temperatures that are some 1-2 K lower than originally. Thus, a 'thermal collapse' (i.e., sudden drop of heat extraction efficiency) will not happen. After calibration of a numerical model with the data from the Elgg system, the extrapolation for an operation over a 30-year period as well as the thermal recovery for 25 years following the end of the operation period has been simulated. Temperature close to the BHE in winter drops quickly in the first years, only to stay more or less stable over the next years. In summertime, initial temperatures are

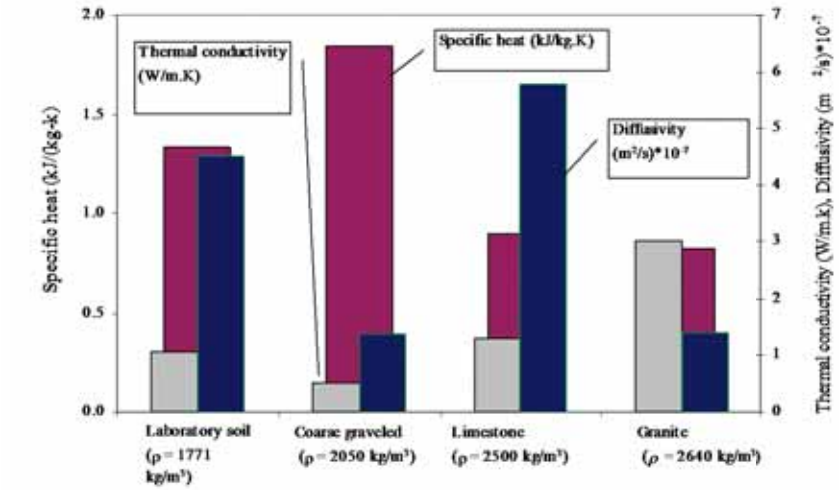


Figure 1: Measured thermal properties for different soils...

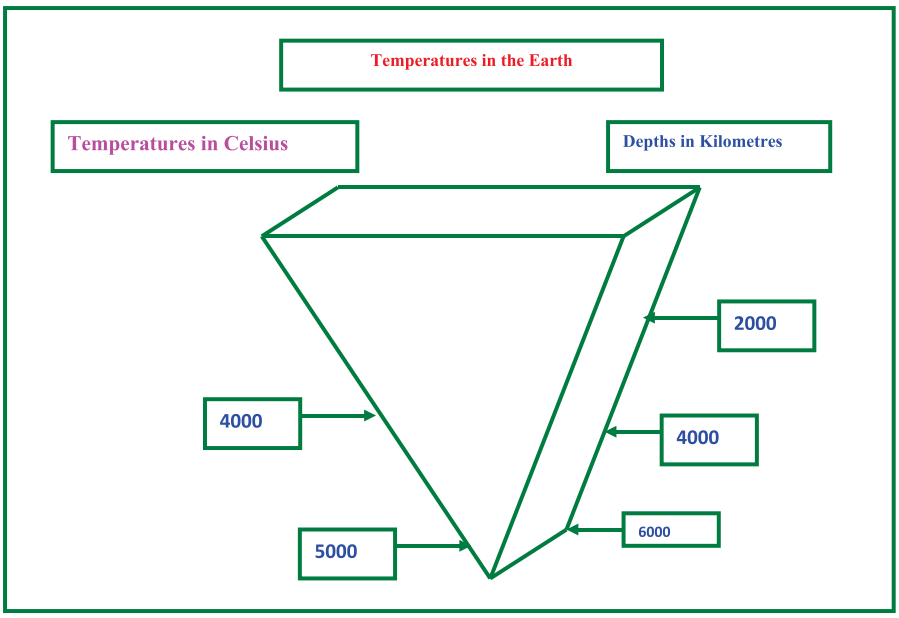


Figure 3: Earth energy budget...

not achieved again, but the temperature drop is decreasing from year to year. After termination of the operation, a rapid thermal recovery can be seen in the first spring, followed by a slowing down of the recovery process due to the decreasing temperature gradients. In the numerical simulation, a complete recovery will occur only after an indefinitely long time period; nevertheless, the remaining temperature deficit 25 years after the operation is stopped, is only in the order of 0.1 K. The long-term reliability of BHE-equipped heat pump systems, along with economic and ecological incentives, led to rapid market penetration. This was accomplished by the development of design standards and easy-to-use design tools.

HEAT PUMPS

Heat pumps work on a similar principle to domestic refrigerators, extracting heat from one source and transferring it to another. A key ingredient in the heat pump is the refrigerant in its coils, usually a substance called Freon, which vaporises into a gas at a boiling point far lower than the 100ºC that water requires to boil. When the refrigerant boils, it changes from a liquid to a gas, absorbing heat from its surroundings. As the refrigerant changes back into liquid form it gives up its heat to the surrounding atmosphere. An expansion valve and an electric compressor control this process of transformation from liquid to gas and back again.

Earth Energy (EE) heat pump is one of the most efficient means available to provide space heating/cooling for homes and offices (Figure 3). It transfers the heat located immediately under the earth's surface (or in a body of water) into a building in winter, using the same principle as a refrigerator that extracts heat from food and rejects into a kitchen. A heat pump takes heat from its source at low temperature and discharges it at a higher temperature, allowing the unit to supply more heat than the equivalent energy supplied to the heat pump. An Earth Energy system relies on the 51% of solar energy that is absorbed by the land and water.

TERMINOLOGY

Due to the large demand for EE as cooling devices, the earth energy industry uses the term 'ton' to describe a unit that will provide approximately 12,000 Btu of cooling capacity. On average, a typical 2,000 square-feet new residence would require a 4-ton unit for sufficient heat. Within the full swing of heat pump applications in Europe, ground-coupled heat pumps play a significant role.

The development started around 1980 when the first BHE coupled heat pump systems were built in Germany and Switzerland. Following a larger number of new units installed during the oil price crises and a subsequent low (except for Switzerland), the number of new installations is again increasing in the 90s.

AIRFLOW

EE units work efficiently because they provide a small temperature rise, but this means that the air coming through the register on the floor is not as hot as the air from a gas or oil furnace. A unit must heat more air to supply the same amount of heat to the houses, and duct sizes must be larger than those used for combustion furnaces to accommodate the higher CFM (cubic feet per minute) air flow.

The major advantage of an EE system is that the heat obtained from the ground (via the condenser) is much greater than the electrical energy that is required to drive the various components of the system. The efficiency of a unit is the ratio of heat energy provided versus the electrical energy consumed to obtain that heat, and it is called its Coefficient of Performance (COP). EE units must exceed 3.0 (i.e., for every kilowatt of electricity needed to operate the system, the heat pump provides three kilowatts of heat energy).

SOIL TYPE

Loose dry soil traps air and is less effective for the heat transfer required in EE technology than moist packed soil. Each manufacturer provides specifications on the relative merits of soil type; low-conductive soil may require as much as 50% more loop than a quality high-conductive soil.

AUXILIARY HEAT

When the outdoor air temperature drops below the design balance point, the EE unit cannot meet the full heating demand inside the house (for units sized to 100% of heat loss, this is not an issue).

The difference in heat demand is provided by the supplementary or auxiliary heat source, usually an electric resistance element positioned in the unit's plenum. Like a baseboard heater, the COP of this auxiliary heater is 1.0; so excessive use of backup heat decreases the overall efficiency of the system and increases operating costs for the homeowner.

BALANCE POINT

The outdoor temperature at which an EE system can fully satisfy the indoor heating requirement is referred to as the balance point, and is usually -10°C in most regions of North Europe. At outdoor air temperatures above this balance point, the unit cycles on and off to satisfy the demand for heat indoors. At temperatures below this point, the unit runs almost continuously, and also turns on the auxiliary heater (called second stage heat) to meet the demand.

HEAT TRANSFER FLUIDS

Closed-loop units can circulate any approved fluid inside the pipe, depending on the performance characteristics desired. Each manufacturer must specify, which fluids are

acceptable to any particular unit, with the most common being denatured ethanol or methanol (the latter is not approved for use).

LOOP DEPTH

EE technology relies on stable underground (or underwater) temperature to function efficiently. In most cases, the deeper the loop is buried, the more efficient it will be. A vertical borehole is the most efficient configuration, but this type of digging can be very expensive.

LOOP LENGTH

The longer the amount of piping used in an outdoor loop, the more heat that can be extracted from the ground (or water) for transfer to the house. Installing fewer loops than specified by the manufacturer will result in lower indoor temperature, and more strain on the system as it operates longer to compensate for the demand.

However, excessive piping can also create a different set of problems, as well as additional cost. Each manufacturer provides specifications for the amount of pipe required. As a broad rule of thumb, an EE system requires 400 feet of horizontal loop or 300 feet of vertical loop to provide heat for each ton of unit size.

LOOP SPACING

When the distances between buried loops are greater, then the efficiency is higher. Industry guidelines suggest that there should be 3m (10 feet) between sections of buried loop, in order to allow the pipe to collect heat from the surrounding earth without interference from the neighbouring loop. This spacing can be reduced under certain conditions.

LOOP CONFIGURATION

Closed loops generally are installed either in a vertical or in a horizontal configuration, depending on the land available and a number of other factors. Earth Energy ground pipe comes in two common diameters: 0.75" and 1.25". Two coiled loops (commonly called the Svec Spiral and the Slinky) require less trenching than conventional straight pipe. As a result, the lower trenching costs and the savings in property disruption offset the higher cost of the coiled pipe.

VARIETIES OF HEAT PUMPS

Air conditioning systems are an example of an air-to-air heat pump. They are becoming increasingly prevalent, particularly because new cars are often fitted with air conditioning systems and people are beginning to ask for more controlled internal environments. However in the UK, the need for air conditioning is often a result of overheating because of unsatisfactory shading and poor natural ventilation. Every attempt should be made to design buildings, which do not require air conditioning, because of the additional energy load required.

In addition to air-to-air heat pumps there are air to water heat pumps and water to air systems. These can draw water from a well or pond and expel the used water to a discharge well. Because the source of heat is fairly constant (about 10ºC) the heat pumps are more efficient than air-to-air systems. Water to water heat pumps are even more efficient, taking the energy from geothermal supplies which are at a constant year round temperature and transferring heat to about 53ºC.

Because heat pumps do not produce very high temperatures, they work best when heating well insulated houses, which are designed to be heated by low temperature systems. Traditional radiators, which are oversized, will give a larger area to dissipate heat and so work at lower surface temperatures. Underfloor water based heating systems are ideal as they work on the radiant heating principle, which creates a comfortable environment at a lower temperature.

The heating loads for a house will vary considerable over the year. At the coldest time of the year, the energy requirements will be greatest. If to design to these levels of maximum load, the heat pumps size can get very big, and as a result costly. It is thought best to design the heat pumps to only cover about 50 to 70% of the annual heating demand, and where demand peaks over a smaller period, to provide supplementary direct electrical heating (or alternatives) to meet this demand.

TYPES OF GEOTHERMAL SYSTEMS

There are a number of different methods to heat a building using geothermal energy:

- Groundwater GSHP, of which there are two variations, open loop and closed loop. An open loop groundwater GSHP supplies ground water directly to each heat pump and then returns the well water to the source. This system is normally not recommended because of fouling and corrosion concerns. The closed loop uses an isolation plate and frame heat exchanger between the ground water and the building water loop.
- Surface-water GSHP, which uses multiple heat exchangers made from spooled plastic pipe submerged in a body of surface water and connected to the building heat pumps.
- Ground heat exchanger GSHP, which relies on a ground-coupled heat exchanger installed either horizontally in trenches or as 'U' tubes in vertical bores.

The heat exchangers are connected together in parallel, and run-outs are tied to the building's water loop. The selection of a particular design depends on the available land area. Table 1 provides the guidelines on the surface-area requirements for horizontal/ vertical configurations. The decision to use any of the above systems depends on the results of geotechnical / hydrogeological investigations.

Table 1: Surface area requirements GSHP (sq metres)

Design	Horizontal	Vertical
2 pipes per trench	2000	3500
4 pipes per trench	1400	2400
6 pipes per trench	1400	2400

WATER DISCHARGE QUALITY

There are environmental regulations, which govern how the water used in an open-loop system can be returned to the ground. A return well is acceptable, as long as the water is returned to the same aquifer or level of water table. A discharge pit is also acceptable, as long as certain conditions are followed.

Open water systems depend on a source of water that is adequate in temperature, flow rate and mineral content. EE units are rated under the nation performance standard (CSA C446) based on their efficiency when the entering water temperature is 10°C (0°C for closed loop units), but this efficiency drops considerably if the temperature of water is lower when it comes from the lake or well. Each model has a specified flow rate of water that is required, and its efficiency drops if this rate is reduced. The CSA installation standard demands an official water well log to quantify a sustainable water yield. Water for open-loop systems must be free of many contaminants such as chlorides and metals, which can damage the heat exchanger of a unit.

SELECTING A GSHP

GSHPs are very similar to conventional heat pumps. Their specifications differ from conventional Water-Source Heat Pumps (WSHP) only in the following areas:

1. GSHPs operate over a very wide range of entering water temperatures from source

(ground), typically, 20ºF to 110ºF, whereas the conventional WSHP operates over a very narrow range (60 to 90°F). This requires the use of an extended-range heat pump to preserve the ability of the system to operate at low ground-water temperatures. Table 2 gives the typical temperature ranges for the water loop of GSHPs.

2. GSHPs with the ground as a heat exchanger must be rated under ARI 330 or CSA 446 closed-loop conditions. GSHPs are to be rated under ARI 325 or CSA 446 open-loop conditions. Conventional heat pumps are rated under ARI 325 or CSA 656 conditions.
3. GSHPs usually use a thermal-expansion valve as opposed to the capillary expansion device used in WSHPs.
4. GSHPs typically encounter low suction temperatures and, therefore, need to be specified with low-temperature/pressure controls for freeze protection.
5. GSHPs usually employ larger liquid side and airside heat exchangers and insulated internal components to prevent internal condensation.
6. In conventional WSHPs, the insulation on the loop piping is not required because the loop temperatures are always maintained above 45°F. GSHP system piping will require insulation, and, in some cases, antifreeze solutions will be required to prevent freeze up.
7. Specify copper heat exchangers for heat pumps on closed-loop ground source, groundwater, or surface-water applications. Use only cupronickel heat exchangers for open ground-water systems.
8. While calculating the loads for the ground-source heat pumps, it is necessary to perform the calculations with an hour-by-hour and month-by-month simulation program because these calculations will be required to design the well field.

Table 2: Entering liquid temperatures for different system types (°F)

Horizontal design	Heating	Cooling
Ground heat exchanger	30-55	90-105
Surface water heat exchanger	30-45	80-95
Closed loop ground water	40-50	75-85
Open loop ground water	50-60	55-65

SELECTION AND PRE-INSTALLATION CONSIDERATIONS

The ground source heat pump (GSHP) system represents the natural evolution of a traditional Water Loop Heat Pump (WLHP) system. The GSHP system offers all the advantages of the WLHP system, combined with considerable reductions in building operating costs. The beauty of this system is that it can perform both heating and cooling without the use of separate boilers/furnaces and A/C systems.

A GSHP system does not create heat; it moves heat from one area to another. GSHP systems use the ground (earth, ground water, or surface water) as heat sink in the summer and a heat source in the winter.

This system is considered to be the most energy-efficient, environmentally safe, and cost-effective system available. Among the many components of a GSHP system, the most important is the heat pump itself.

HEAT PUMP ACCESSORIES AND CONTROLS

Considerations for heat pump:

- Heat pumps, whether water or ground source, should not be used to handle large outdoor air loads. These outdoor air loads should be handled through separate A/C units, preferably with heat-recovery capabilities and conditioned outdoor air ducted to each heat pump.
- Heat-pump sizing is very critical. It doesn't need to oversize heat pumps. In general, size at no less than 95 percent for adequate latent-heat capacity. Do not size greater than 125 percent of the zone peak sensible-cooling load unless the heat pump has multi-speed fan/compressor and automatic means of adjusting flow.
- Pay special attention to the specifications for the on/off automatic valve in the source water-supply connection to the heat pump, which is interlocked with the compressor to permit compressor operation only after it is fully open. Though seemingly a small component in the overall system, this is prone to frequent failures if it is not of good quality. Its failure will lead to expensive compressor failures.
- Heat-pump schedules must include the minimum acceptable coefficient of performance for heating performance and energy efficiency ratio for the cooling performance to take advantage of the most efficient heat pumps available on the market.

GEOTHERMAL HEATING SYSTEMS

Geothermal energy is a natural resource, which can be used in conjunction with heat pumps to provide energy for heating and hot water. CO_2 emissions are much lower than gas fired boilers or electric heating systems. Geothermal heating is more expensive to install initially, than electrical or gas fired heating systems. However, it is cheaper to run, has lower maintenance costs, and is cleaner in use than other sources of heating.

The temperature of the earth under 2 metres of the surface is a fairly constant 10ºC throughout the year. At a depth of about 100 metres, the temperature of any water or rock is at about 12ºC throughout the year. The heat stored at this depth comes largely from the sun, the earth acting as a large solar collector. For very deep wells, in excess of about 170 metres, there is an added component of heat from the core of the earth. As an approximation, one can add 3ºC of heat gain for every 100 metres of depth drilled into the earth.

A closed loop system takes the heat gained from the bedrock itself. In a vertical system a borehole of a diameter of about 150mm is drilled, depth varies between 32 and 180 metres but will depend on the energy requirements. Multiple boreholes can be drilled. A pair of pipes with a special U-bend assembly at the bottom is inserted into the borehole and the void between pipe and hole backfilled with a special grout solution so that the pipe is in close contact with the rock strata or earth. Fluid (referred to as 'brine' is then circulated through this loop and is heated up by the bedrock. Different rock types will give different results. In some cases a number of boreholes will be made (for example, over a car park) to provide sufficient energy for the heat pump supply. If the ground is not suitable, horizontal loops can be laid or even trench filled 'slinky' loops, which are very simple to install. However trench filled systems and horizontal systems require much more ground than vertical systems. If one has a pond or lake nearby then can lay a closed loop at the base of the pond (it needs to be about 2 metres deep), or simply extract the water directly out of the lake at low level and re-distribute it elsewhere in the lake.

Heat pumps can be cheaper to operate than other heating systems because, by tapping into free heat in the outdoor air, ground or water supply, they give back more energy-in the form of heat-than the equivalent amount of electrical energy they consume.

Table 3: Key attributes have been divided into five categories, presented with assessment of the status of GSHP relative to these attributes

Perceived Attribute	Description	GSHP Residential	GSHP Non-Residential
Relative advantage	The degree to which GSHP will perform better than any other space conditioning system.	Opportunity	Opportunity
Divisibility	Ability to try on a limited basis before full adoption.	Barrier	Neutral
Communicability	How well does the technology communicate benefits?	Barrier	Barrier
Compatibility	How closely does a GSHP system compare to conventional HVAC systems?	Barrier	Barrier
Complexity	How easy is it to understand both the benefits and features of the technology?	Barrier	Barrier

For example, in heating mode, a highly efficient heat pump could extract energy from the earth and transfer it into a building. For every 1 KWh of electrical energy used to drive the heat pump, around 3 to 4 kWh of thermal energy will be produced. In cooling mode, the heat pump works in reverse and heat can be extracted from a building and dissipated into the earth. Heat pumps which work in a heating mode are given a 'coefficient of performance' or 'COP' calculated by dividing the input kWh into the output kWh. This will give a COP figure, which varies with the input temperature and is the ratio of energy in to energy out. In cooling mode, the ratio is called the 'energy efficiency ratio' or 'EER'. When the EER and COP ratios higher, the more efficient the unit. Geothermal/GSHPs are self-contained systems. The heat pump unit is housed entirely within the building and connected to the outside-buried ground loop.

THERMAL STORAGE

If the use off peak electricity and want to ensure the even distribution of hot water, then it is worth considering a thermal store. The water, which is heated by the heat pump, can be stored in a large insulated tank at about 50ºC and only used when needed. The thermal store can also link into solar water panels providing an additional source of renewable energy. Thermal storage requirements will vary in size depending on house construction and insulation.

The key to the diffusion of any innovation is the ability to reduce the uncertainty or risk associated with the innovation. There are several diffusion attributes of a technology that help us identify the technology's ability to overcome uncertainty and achieve potential adoption. The key attributes have been divided into five categories, presented below with our assessment of the status of GSHP relative to these attributes (Table 3).

APPLICATIONS FOR EARTH ENERGY

The decision to use geothermal heat pumps should be based on the results of geotechnical/ hydrogeological investigations. Sites may be encountered that are inappropriate for geothermal heat pumps. The geothermal heat-pump system is an all-electric system. A life-cycle analysis, using gas and electric rates, initial costs, maintenance costs, and replacement costs, must be conducted before selecting these systems. These systems may not be cost effective in locations with high electric rates and inexpensive gas. The geothermal heat-pump concept is not a good candidate for buildings that are not expected to have heating loads. EE units can be used for the dehumidification of indoor swimming pool areas, where the unit can dehumidify the air and provide condensation control with a minimum of ventilation air. The heat recovered from the condensed moisture is then used for heating domestic/pool water or for space heating. EE systems are also used as heat recovery devices to recover heat from building exhaust air or from the wastewater of an industrial process. The recovered heat is then supplied at a higher temperature at which it can be more readily used for heating air or water.

Efficient heating performance makes EE a good choice for the heating and cooling of commercial and institutional buildings, such as offices, stores, hospitals, hotels, apartment buildings, schools, restaurants and penitentiaries. EE systems can heat water or heat/cool the interior space by transferring heat from the ground outside, but they can also transfer heat within buildings with a heat-producing central core. The technology can move heat from the core to perimeter zones where it is required, thereby simultaneously cooling the core and heating the perimeter.

HEATING AND COOLING

A GSHP extracts solar heat stored in the upper layers of the earth; the heat is then delivered to a building. A re-circulating piping

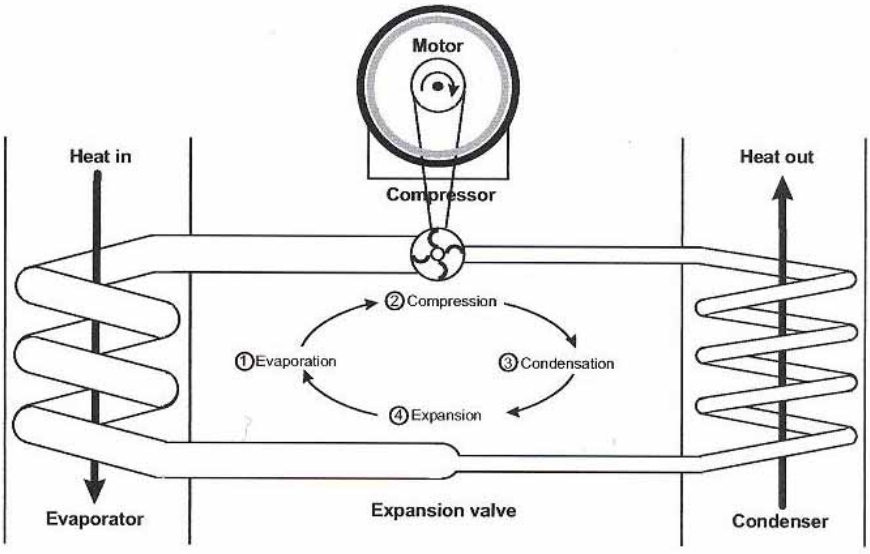
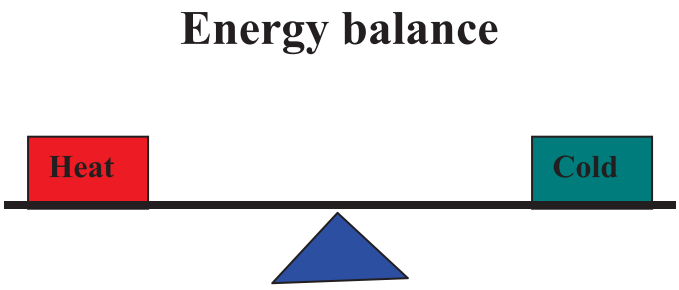


Figure 4: Ground source heat pumps



Energy balance for the ground determines choice of system design of ground

Figure 5. Energy balance for ground...

system connects the heat pump. The piping system adds or removes heat to the circulating water. GSHPs can reduce the energy required for space heating, cooling and service water-heating in commercial/institutional buildings by as much as 50% (Figure 4).

GSHPs replace the need for a boiler in winter by utilizing heat stored in the ground; this heat is upgraded by a vapour-compressor refrigeration cycle. In summer, heat from a building is rejected to the ground. This eliminates the need for a cooling tower or heat rejecter, and also lowers operating costs because the ground is cooler than the outdoor air.

Water-to-air heat pumps are typically installed throughout a building with ductwork serving only the immediate zone; a two-pipe water distribution system conveys water to and from the ground-source heat exchanger. The heat exchanger field consists of a grid of vertical boreholes with plastic u-tube heat exchangers connected in parallel. Simultaneous heating and cooling can occur throughout the building, as individual heat pumps, controlled by zone thermostats, can operate in heating or cooling mode as required. Unlike conventional boiler/cooling tower type water loop heat pumps, the heat pumps used in GSHP applications are generally designed to operate at lower inlet-water temperature.

The GSHP are also more efficient than conventional heat pumps, with higher COPs and EERs. Because there are lower water temperatures in the two-pipe loop, piping needs to be insulated to prevent sweating; in addition, a larger circulation pump is needed because the units are slightly larger in the perimeter zones requiring larger flows. GSHPs reduce energy use and hence atmospheric emissions. Conventional boilers and their associated emissions are eliminated, since no supplementary form of energy is usually required. Typically, single packaged heat pump units have no field refrigerant connections and thus have significantly lower refrigerant leakage compared to central chiller systems. GSHP units have life spans of 20 years or more. The two-pipe water-loop system typically used allows for unit placement changes to accommodate new tenants or changes in building use. The plastic piping used in the heat exchanger should last as long as the building itself. When the system is disassembled, attention must be given to the removal and recycling of the HCFC or HFC refrigerants used in the heat pumps themselves and the anti-freeze solution typically used in the ground heat exchanger.

RADIANT HEATING AND COOLING

There is an alternative source of heat beneath our feet. GSHPs are 380% efficient, 75% renewable and 100% reliable. The land absorbs radiant energy from sun, even on the darkest days (Figure 5). This is stored, every day, and all for free. Solar energy from above and geothermal heat from below maintains the subsurface UK ground temperature within a range of approximately 10°C – even in winter. GSHPs tap this low-grade energy and turn it into usable heat through the simple principle refrigeration- an idea recognised as long ago.

Conventional radiators have been used for many years to heat buildings. The radiators are located around the building perimeter. Because of the small surface area of the radiators, they must be operated at a high temperature to deliver sufficient heat. Modern systems are different in that they cover a large area of floor or ceiling and operate at temperatures much closer to room air temperature, approximately 15°C in cooling mode and 35 to 50°C in heating mode. The system cannot be operated at lower temperatures in cooling mode without the risk of condensation (Figure 6). The small temperature difference means that about 30% to 50% of the ceiling or almost the entire floor area must be available as heat transfer surface. Ventilation air is provided by a small-dedicated ductwork system and works particularly well with displacement ventilation concepts. Several companies have developed metal radiant panels that can be ceiling mounted, either attached directly to the ceiling or as part of a T-bar suspended ceiling. For floor systems, flexible plastic piping is embedded in the concrete floor or in gypsum topping on a wooden sub-floor. Ceiling mounted systems are usually best for combined heating and cooling systems. Floor systems are best for heating-only systems (provided the floor isn't covered with heavy carpets). The amount of heat transfer depends on the direction of heat flow. Air in contact with a cooled ceiling panel will naturally fall as it is cooled increasing the movement of air over the panel. Conversely, air in contact with a warm ceiling will stratify at the ceiling and have low convective heat transfer. As a guide to system sizing, the total heat transfer rate (combined radiation and convection) is about 11 W/m^2/°C temperature difference for cooled ceilings and heated bare floors. This value drops to 6 W/m^2/°C for heated ceilings and cooled floors. Floor coverings such as carpeting reduce the output of heated floors. Radiant systems are more energy-efficient than air-based systems. They require less parasitic energy (pump and fan energy) to deliver heat. The low operating temperatures mean that boilers can operate more efficiently. Finally, because the walls are radiantly heated, the air temperature can be cooler to achieve the same level of comfort. These lower air temperatures result in lower heat losses to the outdoors (Table 4).

HEAT DISTRIBUTION SYSTEM

The heat pump works by promoting the evaporation and condensation of a refrigerant

Table 4: Design load and criteria

Design loads	Capacity (kW)	Annual energy load (MWh)
Heat load winter	410	925
Heat load summer	160	50
Cool load winter	90	190
Cool load summer	330	305

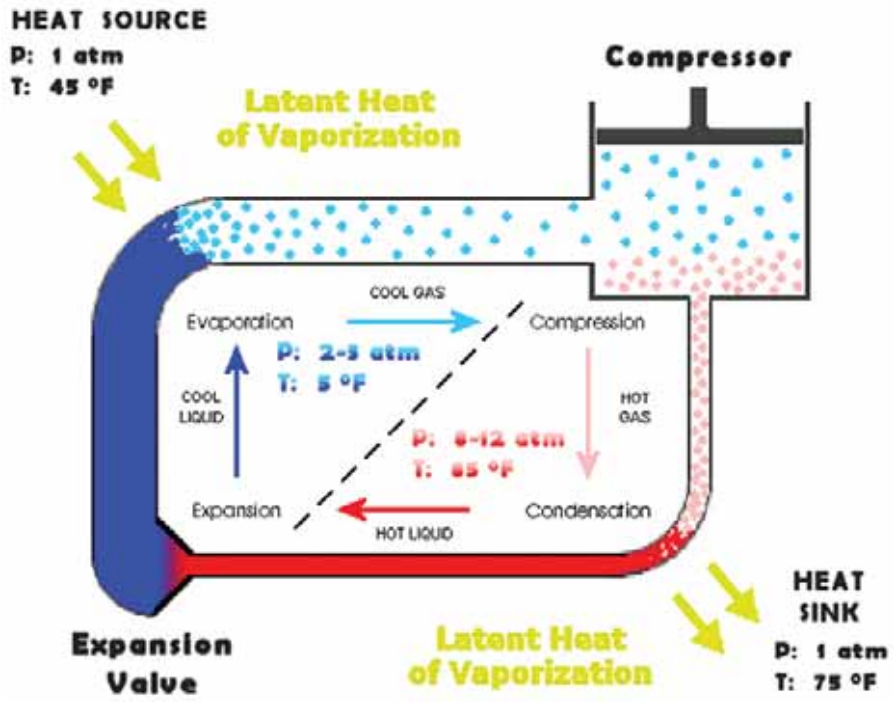


Figure 6: Heat pump works by promoting the evaporation and condensation of a refrigerant...

to move heat from one place to another (Figure 6). A heat exchanger transfers heat from the water/antifreeze mixture in the ground loop to heat and evaporate refrigerants, changing them to a gaseous state. A compressor is then used to increase the pressure and raise the temperature at which the refrigerant condenses. This temperature is increased to approximately 40°C. A condenser gives up heat to a hot water tank, which then feeds the distribution system. Features include: Lower utility bills, less maintenance, no visible outdoor plant, reduction in emissions, and versatility of system.

Because GSHPs raise the temperature to approximately 40°C they are most suitable for under floor heating systems, which require temperatures of 30 to 35°C, as opposed to conventional boiler systems, which require higher temperatures of 60 to 80°C. GSHPs can also be combined with radiator space heating systems and with domestic hot water systems. However top-up heating would be required in both cases in order to achieve temperatures high enough for these systems. Some systems can also be used for cooling in the summer. Geothermal heat pumps are the most energy efficient, environmentally clean, and cost effective space conditioning systems available according to the Environmental Protection Agency in the United States of America. Ground Source Geothermal heating and cooling is a renewable resource, using the earth's energy storage capability. The earth absorbs 47% of the suns energy amounting to 500 times more energy than mankind needs every year.

The closed loop portion of a ground source heat pump system consists of polyethylene pipe buried in the ground and charged with a water/antifreeze solution. Thermal energy is transferred from the earth to the fluid in the pipe, and is upgraded by passing to a water source heat pump. One 100 metres vertical closed loop borehole will typically deliver 14000 KWh of useful heating energy and 11000 KWh of useful cooling energy every year for life. For typical commercial building early trials indicate annual HVAC energy consumption in the order of 75 kWh/m² compared with 156 kWh/m² 'good practice target', and 316 kWh/m² typical consumptions published by the Department of the Environment in Energy Consumption Guide No.19. Low energy consumption means associated lower CO_2 emissions than from conventional systems.

Energy savings of 40% compared with air source heat pumps and by over 70% compared to electric resistance heating are being achieved, and CO_2 emissions are reduced to 40 kg/m², less than half that associated with DOE typical HVAC design. With the heat source buried in the ground, the system is both invisible and silent. There is no need for boiler, flue, cooling tower, water treatment or associated plant rooms, and the total building resource content is reduced.

This invention relates to a cooling and heating system, which operates on the absorption and phase change heat exchange principle. More particularly it relates to a continuous heat actuated, air cooled, double effect generator cycle, absorption system. In further aspects, this invention relates to a system constructed for use with an absorption refrigeration solution pair consisting of a nonvolatile absorbent and a highly volatile refrigerant, which is highly soluble in the absorbent. A disclosed refrigerant pair is ammonia as the refrigerant and sodium thiocyanate as the absorbent. An absorption cycle is disclosed using the thermo physical

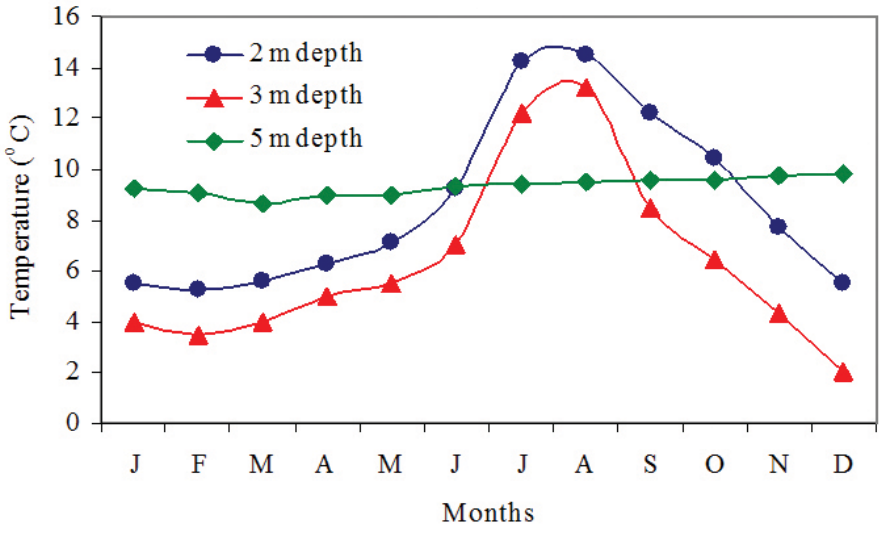


Figure 7: Ground temperatures throughout the year...

properties of sodium thiocyanate/ammonia, absorption/refrigerant pair. Also, disclosed is the construction and configuration of a reverse cycle air cooled double effect generator absorption refrigeration system for use with the sodium thiocyanate/ammonia refrigeration pair, as well as sub-compositions, subsystems and components that improve the system efficiency and reduce cost.

At a depth of 5.5 metres, the earths temperature will be constant at a temperature equal to the average mean ambient temperature throughout the year in any location meaning temperature in winter higher than the air temperature, and in summer lower than air temperature thereby providing higher efficiencies in both heating and cooling modes and ensuring a lower peak load throughout the year.

There is unlikely to be a potentially larger mitigating effect on greenhouse gas emissions and the resulting global warming impact of buildings from any other current, market-available single technology, than from ground-source heat pumps. Over its first year of operation, the ground source heat pump system has provided 91.7% of the total heating requirement of the building and 55.3% of the domestic water-heating requirement, although only sized to meet half the design-heating load. The heat pump has operated reliably and its performance appears to be at least as good as its specification. The system has a measured annual performance factor of 3.16. The occupants are pleased with the comfort levels achieved and find the system quiet and unobtrusive. The heat pump is mounted in a cupboard under the stairs and does not reduce the useful space in the house, and there are no visible signs of the installation externally (no flue, vents, etc.). The ground source heat pump system is responsible for lower CO_2 emissions than alternative heating systems (the emission figures for an all-electric system and oil- or gas-fired boilers are given in table 4). For example, compared with a gas-condensing boiler, the heat pump system resulted in 15% lower CO_2 emissions (assuming a CO_2 emission factor for electricity of 0.46 kg/kWh). When compared with a new oil-fired boiler system or an all-electric system, the emissions of CO_2 are cut by over 40% and nearly 60% respectively.

Annual fuel costs, based on the fuel prices and are about 10% higher than those for a gas condensing boiler and about 20% higher than for a new regular oil boiler, but servicing costs are likely to be lower. Running costs are substantially cheaper than for an all-electric heating system. At present, suitable products are not readily available in the UK, so the heat pump had to be imported.

This had some drawbacks, e.g., limited documentation in English and possible difficulty in obtaining spare parts. The controller supplied with the heat pump was not designed for use with an Economy 7 type tariff structure. There is however potential to improve the operation of the system by scheduling more of the space and water heating duty during the reduced tariff period.

The performance of the heat pump system could also be improved by eliminating unnecessary running of the integral distribution pump. It is estimated that reducing the running time of this pump, which currently runs virtually continuously, would increase the overall performance factor to 3.43.

This would improve both the economics and the environmental performance of the system. More generally, there is still potential for improvement in the performance of heat pumps, and seasonal efficiencies for ground source heat pumps of 4.0 are already being achieved.

It is also likely that unit costs will fall as production volumes increase. By comparison, there is little scope to further improve the efficiency of gas- or oil-fired boilers.

CONCLUSIONS

Conventional heating or cooling systems require energy from limited resources, e.g., electricity and natural gas, which have become increasingly more expensive and are at times subjects to shortages.

Much attention has been given to sources subject to sources of energy that exist as natural phenomena. Such energy includes geothermal energy, solar energy, tidal energy, and wind generated energy. While all of these energy sources have advantages and disadvantages, geothermal energy, i.e., energy derived from the earth or ground, has been considered by many as the most reliable, readily available, and most easily tapped of the natural phenomena.

This study has dealt with the modelling of vertical closed-loop and ground source heat pump system. The challenges associated with the design of these systems originate from the fact that they present a unique type of heat transfer problem.

First, there are inherent inabilities to make direct observations in the subsurface environment with respect to both space and time. Secondly, heat transfer within the subsurface environment can be highly transient. Consequently, a considerable amount of research in the past decade has been geared towards optimising the design and performance of GSHP systems and this study is part of those efforts.

The installation and operation of a geothermal system may be affected by various factors. These factors include, but are not limited to, the field size, the hydrology of the site the thermal conductivity and thermal diffusivity of the rock formation, the number of wells, the distribution pattern of the wells, the drilled depth of each well, and the building load profiles.

The performance of the heat pump system could also be improved by eliminating unnecessary running of the integral distribution pump. This would improve both the economics and the environmental performance of the system.

The results of soil properties investigation have also demonstrated that the moisture content of the soil has a significant effect on its thermal properties. When water replaces the air between particles it reduces the contact resistance.

Consequently, the thermal conductivity varied from 0.25 W/m/K for dry soil to 2.5 W/m/K for wet soil. However, the thermal conductivity was relatively constant above a specific moisture threshold.

In fact, where the water table is high and cooling loads are moderate, the moisture content is unlikely to drop below the critical level. In Nottingham, where the present study was conducted, soils are likely to be damp for much of the time. Hence, thermal instability is unlikely to be a problem. Nevertheless, when heat is extracted, there will be a migration of moisture by diffusion towards the heat exchanger and hence the thermal conductivity will increase.

ACKNOWLEDGMENT

The financial support for this research work is from the Energy Research Institute (ERI). Thanks to my wife Kawthar Abdelhai Ali for her warmth and love. Her unwavering faith in me, her intelligence, humour, spontaneity, curiosity and wisdom added to this article and to my life. ■

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Energy Efficient **Chillers**

Image: www.azane-inc.com

These devices in whatever shape and size are becoming indispensable with the changing life style – and putting a great pressure on the energy consumption. As energy costs continue to increase, conservation strategies have become crucial...

A chiller is a machine that removes heat from a liquid via a vapour-compression or absorption refrigeration cycle. This liquid can then be circulated through a heat exchanger to cool air or equipment as required. Chillers for cooling in different applications (home and industrial), for different temperature environments (low, medium and high), with different types (air, water, ammonia etc) and different shapes (process, scroll, screw etc.) have become a significant part of consumers' lives. These devices in whatever shape and size are becoming indispensable with the changing life style – and putting a great pressure on the energy consumption/utilization – thus the environmental sustainability. There is a great need to go far energy efficient chillers. This article presents a brief summary about the need, development status and tips for making the use of chillers more energy efficient and environment friendly.

Energy consumption

Chillers often represent a plant's single largest electric load. A 600-ton chiller can draw 0.547 kW/ton, which, at a rate of $0.08 per kWh, adds up to more than $200,000 per year in operating costs. Factor in fouled tubes, leaking refrigerant, changes in water temperature and a myriad of other variables and operating costs can escalate by 8 to 10 percent an additional $20,000 per year. Operating a chiller at its peak performance saves energy as well as maintenance costs.

It is estimated that chillers consume 20 percent of the total electrical energy generated in North America, making it very important to reduce consumption in this area. Chillers are the single largest user of electricity in most commercial and institutional facilities. In many cases, they are the single largest user of any form of energy in buildings. As energy costs continue to increase, conservation strategies have become crucial. There are a number of steps we can take – that not only will improve the operation of the chiller system but also will increase overall system energy efficiency.

Efficiency requirements

Chiller efficiencies have improved significantly during the past 10 years, mostly as a result of new refrigerants and microprocessor controls, as well as improved compressor and motor design. However, high-tech chillers have narrower tolerances, so that service and upkeep are more crucial than ever for keeping them operating at peak performance. In the past, the most commonly used measure of chiller performance was full-load efficiency rating. Engineers and managers often used the efficiency rating, expressed in kilowatts per ton (kW/ton), to determine the most efficient chiller for a particular application. While the rating did indicate a chiller's relative efficiency, it had a serious drawback. It was only valid for a chiller operating at full load.

As the load on a chiller falls, so does its operating efficiency. Most chillers operate at full load for about 1 percent of their annual operating hours. That means that for 99 percent of a chiller's operating hours, it operates at less than its full-load efficiency.

This situation creates two problems. First, in making the purchase decision at least in part on different chillers' full-load operating efficiency, a manager might not have selected the most efficient chiller for the application. Second, estimating a chiller's annual energy use based on the full-load efficiency rating will result in seriously low estimates. Managers now have a better estimate of chiller performance that can correct both of these problems.

Comparison

In recent years, chillers have generally become more energy efficient, even though at the same time most of them use low ozone-depleting refrigerants with lower heat-transfer capacities. Today's designs are 10-30 percent more efficient than previous generations of equipment. In most cases, chillers can be expected to become even more efficient over the next decade because of improved microprocessor control, superior flow and temperature measurement, and the introduction of larger heat exchangers. Different chiller designs have different areas of strength, although some are inherently more efficient in terms of energy units consumed per unit of chilled water produced.

- Water-cooled chillers, which use water to remove the heat, are twice as energy efficient as air-cooled chillers, which use the flow of outside air to remove heat from the chiller.
- Newer chillers often have variable frequency drives whereas in older systems, cooling tower fans run continuously at full speed, causing excess energy and money to be wasted.

Useful strategies

- Purchasing the most efficient chiller is only the first step in minimizing energy costs.
- Once installed, an organisation must maintain the chiller properly if it is to perform as efficiently as possible. In most cases, any savings produced by cutting back on chiller maintenance will be more than offset by increased energy costs.
- Maintenance and engineering managers looking for ways to improve the energy efficiency of their buildings start by improving the efficiency of chillers.
- Managers have two primary options to improving chiller performance: replacement and maintenance. Today's replacement chillers offer managers benefits in both performance and operating efficiency, making any chiller more than 10-15 years old a replacement candidate.
- Selecting the most appropriate chiller for a particular application. Slight differences between different models can result in rather large differences in the annual energy requirements for cooling a facility.
- Managers must have enough information to determine – if reduced annual energy costs of one model are enough to justify what might seem like a significant difference in first costs.
- The best way to improve chiller compressor motor efficiency is by upgrading motor control from constant- to variable-speed using a Variable Frequency Drive (VFD). Rising energy costs and electric utility rebates for VFD upgrades, coupled with falling prices for large horsepower VFDs, can reduce investment payback times to as little as one year. Managers also should consider the option of equipping existing and replacement chillers with variable-speed drives. Conventional chillers operate at a constant speed. As the load decreases, vanes in the inlet to the compressor close, reducing the chiller's output. This change also reduces the chiller's energy use, but the decrease in energy use does not directly match the decrease in the chiller's output. A variable-speed drive reduces the output of the chiller by reducing the speed of its compressor. As the chiller speed decreases, so does the compressor's energy use. When evaluated on an annual basis, the average energy savings produced by the variable-speed drive is about 30 percent, providing a rapid return on the investment.
- One feature that has improved energy efficiency of today's chillers is the performance of heat-transfer surfaces within chillers. But the performance of these surfaces requires that they be clean

and free of buildup, including sludge, corrosion, algae, and scale. Even a very thin layer deposited on the surface can result in a significant decrease in efficiency. To keep these surfaces clean, technicians should clean the condenser tubes annually. Evaporator tubes require cleaning only every three or four years, since they function in a closed system that has limited exposure to contaminants.

- New materials are now being developed that are a step change in the amount of water they can hold. These materials are known as Metal-Organic Framework (MOF) compounds. Some of the recent ones will adsorb more than four times as much water as silica gel. As the name implies, these materials are made of various metals, such as zirconium or chromium, bound together with a loose web of carbon atoms, so that there is a much greater surface area with sites where water molecules can be bound. At present, such materials will work well for a few cycles of adsorption and its reverse, desorption but a commercial adsorption chiller needs to keep up this performance for thousands of cycles without requiring a change of the MOF. The first materials are undergoing such tests, and if they succeed we might soon see commercial air conditioning using 10% of the energy required for today's units.

Additional tips for improving chiller efficiency

- Lowering the temperature of the water entering the condenser can improve the chiller's efficiency.
- Flow rate must be regulated closely, because too low a flow rate reduces chiller efficiency, leading to laminar flow.
- The amount of cooling that any chiller can provide depends on how much refrigerant it moves through the compressor per unit time. It's important to maintain the proper level of refrigerant.
- Leaks, as well as air and moisture, decrease efficiency and system reliability.
- For efficient starter and motor operation, check the safety and sensor calibrations on microprocessor controls.
- A modern and intelligent technology is to control the large power demands of screw compressors with the frequency control network, using inverter electronic devices.
- Prepackaged retrofit for centrifugal compressor chiller also said to reduce required maintenance and extend operating life. This type of package is most effective retrofitted to centrifugal compressor chillers, but can also be applied to other chiller types, including those with reciprocating, rotary-scroll, or screw compressors.

Acknowledgement

The use of information retrieved through various references/sources of internet in this article is highly acknowledged. ■

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GE's FirstBuild Invites Design Ideas

A microfactory in the heart of the University of Louisville's campus, FirstBuild designs, builds and sells the next generation of innovative home appliances...

GE's FirstBuild is a global co-creation community that harnesses the brainpower of the maker movement to change the way major home appliances are conceived, designed and manufactured. It has announced the development of its new Pique Coffee Brewer by launching the Cold Brew Challenge: a product design competition drawing upon the power of crowdsourced design and the FirstBuild community.

Pique is expected to go to market this summer on Indiegogo, the world's largest crowd funding platform. In a bold move, FirstBuild is offering a portion of the proceeds from the Indiegogo campaign to the top three challenge entries. Information on both the product and the challenge can be found at piquecoldbrew.com.

A microfactory in the heart of the University of Louisville's campus, FirstBuild designs, builds and sells the next generation of innovative home appliances. FirstBuild is brewing up the core technology, but is reaching out to the community to create a beautiful design.

FirstBuild is offering its registered community members the chance to once again show off their extraordinary industrial design capabilities and user-experience insights by entering the Cold Brew Challenge.

How to submit your design:

- Not a FirstBuild member? Sign up for free at www.firstbuild.com
- FirstBuild members can download and take a look at initial CAD design files and decide where the potential lies – or scrap it entirely and start from scratch
- Take advantage of a special free download of Autodesk Fusion 360
- Submit innovative designs by March 27, 2016

Winning designs will be selected by the FirstBuild community and a panel of selected design experts in early April, followed by a summer 2016 pre-sale and crowdfunding campaign on Indiegogo in order to help fund development and marketing for launch. "We're looking for beautiful, functional design that will wow coffee enthusiasts. Cold brew is different – it's richer, smoother and more aromatic than typical iced coffee, and we need the product design to match," said Taylor Dawson, Product Evangelist at FirstBuild.

Also, for the first time, FirstBuild is offering 1% of the campaign funding from Indiegogo to be shared by the winning designers, up to $30,000 in total awards. ■

Masanori Togawa, President and CEO, Daikin

Acquiring Flanders will enable American Air Filter Company Inc. (AAF), a subsidiary of Daikin, to develop high value-added products including those used for cleanrooms in the pharmaceutical field and in food processing…

In October 2014, Daikin Industries Ltd. celebrated the 90th anniversary of its founding. A company with core businesses in the fields of air-conditioning systems, fluorochemicals, oil hydraulics, and defence products, Daikin has continually evolved in step with the times and in response to social paradigm shifts. In its pursuit of improved energy conservation performance and environment-friendliness, Daikin has repeatedly realized important innovations with respect to air-conditioning and refrigerant technologies. The company's development of new applications for fluoroplastics, fluororubbers, and fluorochemicals has spurred major changes in people's work and lives. Their main market foci have been gradually shifting from Japan to overseas. In the words of Masanori Togawa, President and CEO, Daikin, "Going forward, the Daikin Group will expand business globally while reforming its business model and improving the environmental performance of its products and technologies."

Walking on the planned course, Daikin Industries Ltd., through its subsidiary American Air Filter Company Inc. has decided to acquire U.S. air filter manufacturer Flanders Holdings LLC. The acquisition price is 430 million dollars (approximately 50.7 billion yen at an exchange rate of 1 USD = 118 JPY). Daikin is to acquire all shares of Flanders from Insight Equity Holdings LLC, an investor in the company. The acquisition is expected to be concluded in April 2016 after completion of the necessary procedures.

Daikin Is Targeting 100 Billion Yen Annually Through Acquisition

Expertise of Flanders

As the leading air filter manufacturer in the United States, Flanders is particularly adept in products with high functionality and high value-added that are used in industrial cleanrooms such as those in the fields of pharmaceuticals and food processing. The company boasts a broad lineup ranging from commercial to residential use and a nationwide sales network. Flanders has manufacturing bases near most major U.S. cities, including Chicago and New York, and excels in short lead times and low logistics costs to deliver products that are cost competitive.

Filter Market

The scale of the global air filter market is reported to be 450 billion yen overall. Of that, the U.S. market is the largest market, accounting for approximately 190 billion yen. The lineup comprises a wide range of products, including pharmaceuticals and semiconductors, where control is sought for air conditioning and maintaining strict air environments. Furthermore, recent improvements in the high tech industry have raised expectations for clean air, and there is also a need for high functionality in air filters that corresponds to a greater awareness for energy savings and the environment that has driven stricter environmental regulations.

Daikin's Interest

Having established manufacturing bases in the regions of Japan, North America, Europe, China, and Southeast Asia, Daikin has expanded its filter business until now through its subsidiaries AAF and Nippon Muki Co., Ltd. Products have focused on commercial-use air conditioning filters used in buildings and factories and engineering fields, including dust collection systems for production facilities. AAF has closely embedded itself in each region of the world and performs development, production, sales, and services for products satisfying the needs of an extensive market.

Expectations from the Acquisition

With this acquisition, the Flanders business will be integrated into AAF and enable AAF to leverage its global sales network to market the cleanroom equipment and high-end air filter products that are the strengths of Flanders. In addition to making AAF the leading manufacturer in the United States, which is reportedly the largest air filter market in the world, this merger will also position AAF as a leading company in the global market.

As a result of the merger, the filter business of the Daikin Group will become a business with sales exceeding 100 billion yen annually. Future synergies with the air conditioning business are anticipated as the filter business transforms into a core Daikin business as a third pillar behind air conditioning and chemicals. The merger will also serve to improve air environments in homes, buildings, and factories; better address global environmental issues, including mitigation of air pollution; and meet the need that is increasing worldwide for creation of comfortable air environments.

Significance of the Acquisition

Acquiring Flanders will enable AAF to develop high value-added products – including products used for cleanrooms in the pharmaceutical field and in food processing, which are specialty areas for Flanders, and provide a complete product lineup ranging from commercial to residential use. Synergy is also anticipated from the utilization of AAF's expanding global sales network and proposals that combine products of both companies. From the aspect of manufacturing, Daikin intends to capitalise on the proximity of Flanders' manufacturing bases to major markets and its superiority in logistical costs and lead time. Improvement is also expected in cost competitiveness, such as in procurement savings.

As concerns around Indoor Air Quality (IAQ) and improving the quality of indoor air environments have increased, air filters have become an increasingly important business given their ability to improve environments by providing mildew prevention, deodorization, and solutions to the PM 2.5 problem. The filter business strongly complements the air conditioning business, a mainstay business of the Daikin Group, and is expected to become an important business in the future as an inroad to environmental fields and expansion of the solution business.

Post-Acquisition Organisation

In this acquisition, Flanders will be integrated into AAF, the subsidiary of Daikin Industries. While operation management will rest with AAF, the policy will be to fundamentally maintain the manufacturing and sales systems that have made Flanders a leading supplier in the United States. ■

post event **report**

ACREX India 2016

Witnesses An August Assembly Of Quality Visitors

The 2016 edition of ACREX India, South Asia's leading industry trade show in the fields of Heating, Ventilation, Air Conditioning and Refrigeration (HVAC & R) and building services, which had been held at Bombay Convention & Exhibition Centre in Mumbai from 25 to 27th February, successfully dragged a huge crowd of field decision makers, technocrats, traders, financiers, media people and many others.

The 17th edition of ACREX India successfully and strategically managed to display the latest developments in the fields of HVAC&R. Beside launch of several new products in the event, there were displays of amazing retrofitting technologies, which addressed the concerns of today's economic situation.

While in the country, awareness is growing on preventing spoilage of agro-produces and adding value to them – and transporting the final products in undeteriorated condition to places far off from the point of production, the concerned industry people are always in search of new methods and the state-of-the-art technologies to address the challenges concerned therewith. ACREX 2016 had a lot to address their challenges. The same is true for the pharma industry.

Our prime minister's call for 'Make in India' got well resonated in the venue. It was quite interesting to watch several innovative products from the small Indian companies beside the big ones and multinationals. Stringent focus on energy saving was reflected in most of the technologies on display. Also, there were many technologies to directly address the challenges of environment management.

ACREX 2016 has created a good impact among the visitors as the total arrangement was good. Thanks to organisers' sincere efforts, which were quite evident in the whole event. The next event, ACREX India 2017 will be held at India Exposition Mart Ltd. (IEML), Greater Noida, Delhi/NCR from 23rd to 25th February 2017. ■

ifm electronic offers new calorimetric flow meters

ifm electronic's new calorimetric flow meters for liquids and gases are optimised for water, oils, glycol and air. The devices feature a fast response time and integrated temperature measurement. In the absolute mode the internal pipe diameter can be set from DN15 ... DN400. Moreover, the flow meters come with a red/green colour selection for process values and optimised alignment thanks to the rotatability of the process connection.

Measuring principle

The SA type flow meter operates on the calorimetric measuring principle. Two measuring elements as well as a heat source are located on the measuring tip. The physical effect that a flowing medium absorbs heat energy and conducts it away is used. The resulting temperature change is an indication of flow.

Device function

The new SA type sensor has been designed to detect and measure flow and temperature even in large internal pipe diameters up to 400 mm. Therefore, it can be used in a multitude of applications. Switching outputs, analogue signals and IO-Link provide various options to further process the signals. That means that the user is best-equipped for Industry 4.0.

Website: www.ifm.com

Parker offers award winning braze-free connectors

Sporlan Division of Parker Hannifin Corporation was informed that ZoomLock, a braze-free HVAC/R copper connecting concept received the 2016 AHR Expo Innovation Award for the Tools and Instruments Category. The annual awards competition honors the most inventive and original HVAC/R products, systems, and technologies showcased at each year's AHR Expo.

Press-to-connect fittings were developed over 20 years ago and have been widely adopted in the plumbing industry due to the significant time savings, repeatability, and simplicity of installation. However, ZoomLock's patented design is the ONLY press-to-connect technology that is approved for HVAC/R operating pressures up to 700 psi.

One technician can quickly do the connecting job alone, with no torch, no hot-work permits, no safety equipment and no special experience. In just minutes, ZoomLock provides a clean, leak-proof connection, and the fittings are more repeatable than brazed joints. By eliminating concerns about gas and flames, ZoomLock also gives you more flexibility in where and when you can work, plus there's no need to nitrogen-purge the lines.

Website: www.parker.com

E+E Elektronik offers active temperature sensors for HVAC systems

The temperature sensors from E+E Elektronik are also available with 0-10 V or 4-20 mA outputs. The active sensors extend the portfolio of the Austrian sensor specialist in the field of HVAC and building technology. The compact, innovative housing and mounting concept with protection class IP65 / NEMA 4 facilitates extremely simple and fast installation of the sensors.

The E+E temperature sensor range includes duct mounted types, sensors for wall mounting indoors and outdoors, a strap-on sensor for mounting on ducts and pipes, and a version with remote probe. Special immersion wells with innovative mounting spring turn the duct versions into immersion sensors for temperature measurement in fluids.

The sensors offer outstanding accuracy and a wide temperature range. The measured values are available at a 0-10 V or 4-20 mA output. The factory scaling is freely selectable and can be subsequently changed by the user by means of an optional configuration kit and free configuration software.

Website: www.eplus.com

Nortek Launches New 95% Efficient Furnace

The factory-installed fixed-torque ECM blower motor is programmable to 16 different speeds for both heating and cooling operation modes…

Nortek Global HVAC, a Nortek company and a leading manufacturer of energy-efficient HVAC systems, has added a new furnace to its lineup. Model KG7SD-E achieves up to 95% AFUE, and comes with a factory-installed fixed-torque ECM motor, making it ideal for the Canadian market, where all furnaces must now include ECM motors. In addition to Canadian sales, this new furnace qualifies for local utility rebates and the U.S. federal tax credit.

The factory-installed fixed-torque ECM blower motor is programmable to 16 different speeds for both heating and cooling operation modes, so it is extremely adaptable to challenging high-static applications as well as a greater range of heating and cooling capacities.

"With the growth of utility rebates and renewal of federal tax credits, a greater number of homeowners are choosing high-efficiency gas furnaces. We want to give customers a wide range of options in the condensing furnace category. The new KG7SD-E furnace reflects our commitment to high-value products that save homeowners money every heating season," says John Remley, Nortek Global HVAC Product Manager.

Website: www.nortek.com

RHT3 EzSmart Hygro-Thermometer

Make your iOS and Android Smart Devices even smarter with this EzSmart Hygro-Thermometer and free app from iTunes and Google Play store! Take quick, readings of Humidity and Temperature. Further analyse these readings with the handy trend graph feature. It's fully functional like a regular all purpose Hygro- Thermometer for a fraction of the cost!

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- Post images directly to social media (Facebook® and Twitter™)
- Complete with built-in sensor and protective connector cap with strap

1. Simultaneously displays Temperature and Humidity
2. Graph and chart (however the photo you have does not show a graph
3. display temperature and Humidity directly on images

Website: www.extech.com

index to **advertisers**

Salesforce's 350 Mission office tower in San Francisco wins LEED award

This 350 Mission Street is a 30-story office tower located in downtown San Francisco... (Image © SOM | AJSNY)…

Designed by Skidmore, Owings & Merrill LLP (SOM), 350 Mission has been awarded LEED Platinum certification by the U.S. Green Building Council (USGBC). LEED, or Leadership in Energy and Environmental Design, is an internationally recognized mark of excellence that provides building owners and operators with a framework for identifying and implementing practical and measurable green building design, construction, operations and maintenance solutions.

Scheduled to officially open this summer, 350 Mission Street is a 30-story office tower located in downtown San Francisco. The project exemplifies a regenerative urban ecology in which environmental, social, cultural, and economic sustainability is applied to the making of the architectural form. A 50-foot-high urban living room at the building's base is designed as a vibrant space that blurs the boundaries between public and private realms. Cutting energy costs by one-third, energy conservation strategies include zoned under-floor HVAC distribution and high performance, insulated glass cladding units that reduce solar heat gain while maximising visibility and daylighting.

[Source: Skidmore, Owings & Merrill LLP (SOM)] ■

CIBSE Building Performance Champion / Project of the Year - Leisure

The theatre has achieved an excellent BREEAM rating as a result of the measures taken…

Like a phoenix from the ashes, the new £27 million Everyman Theatre has risen triumphantly from the site originally occupied by its much loved, but ailing predecessor. The reborn theatre, which opened in 2014, features outstanding energy efficiency, maximised with the help of the building's fabric and, in particular, its dramatic façade which employs sophisticated active solar shading.

To boost environmental performance still further, the auditorium uses natural stack ventilation, minimising the energy consumption of fans and ventilation equipment. This is supported by a mechanical system to cope with peak loads. Low energy lighting and controls complete the energy saving measures of this iconic building.

The theatre has achieved an Excellent BREEAM rating as a result of these measures. At the outset, the challenge for m&e engineer Waterman Building Services (WBS) was to provide a low energy theatre with a naturally ventilated auditorium in a particularly challenging location – the crowded university and cathedral quarter of Liverpool. ■

Declaration FORM IV

Statement about ownership & other particulars of the newspaper entitled COOLING INDIA required to be published under Rule 8 of the Registration of Newspapers (Central Rules, 1956).

1.	Place of Publication	: 201, Premalaya, Opp.Telecom Factory, Deonar, Mumbai - 400 088.
2.	Periodicity of Publications	: Monthly (15th of every month)
3.	Publisher's Name	: Pravita Iyer
	Nationality	: Indian
	Address	: As above
4.	Printer's Name	: Pravita Iyer
	Nationality	: Indian
	Address	: As above
5.	Editor's Name	: P.K. Chatterjee
	Nationality	: Indian
	Address	: As above

6. Name and addresses of individuals who own the newspaper and partners or shareholders holding more than one percent of the total paid up capital
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     201, Premalaya, Opp.Telecom Factory,
     Deonar, Mumbai - 400 088.
   - Pravita Iyer
     201, Premalaya, Opp.Telecom Factory,
     Deonar, Mumbai - 400 088.
7. I, Pravita Iyer, hereby declare that the particulars given above are true to the best of my, knowledge and belief.

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

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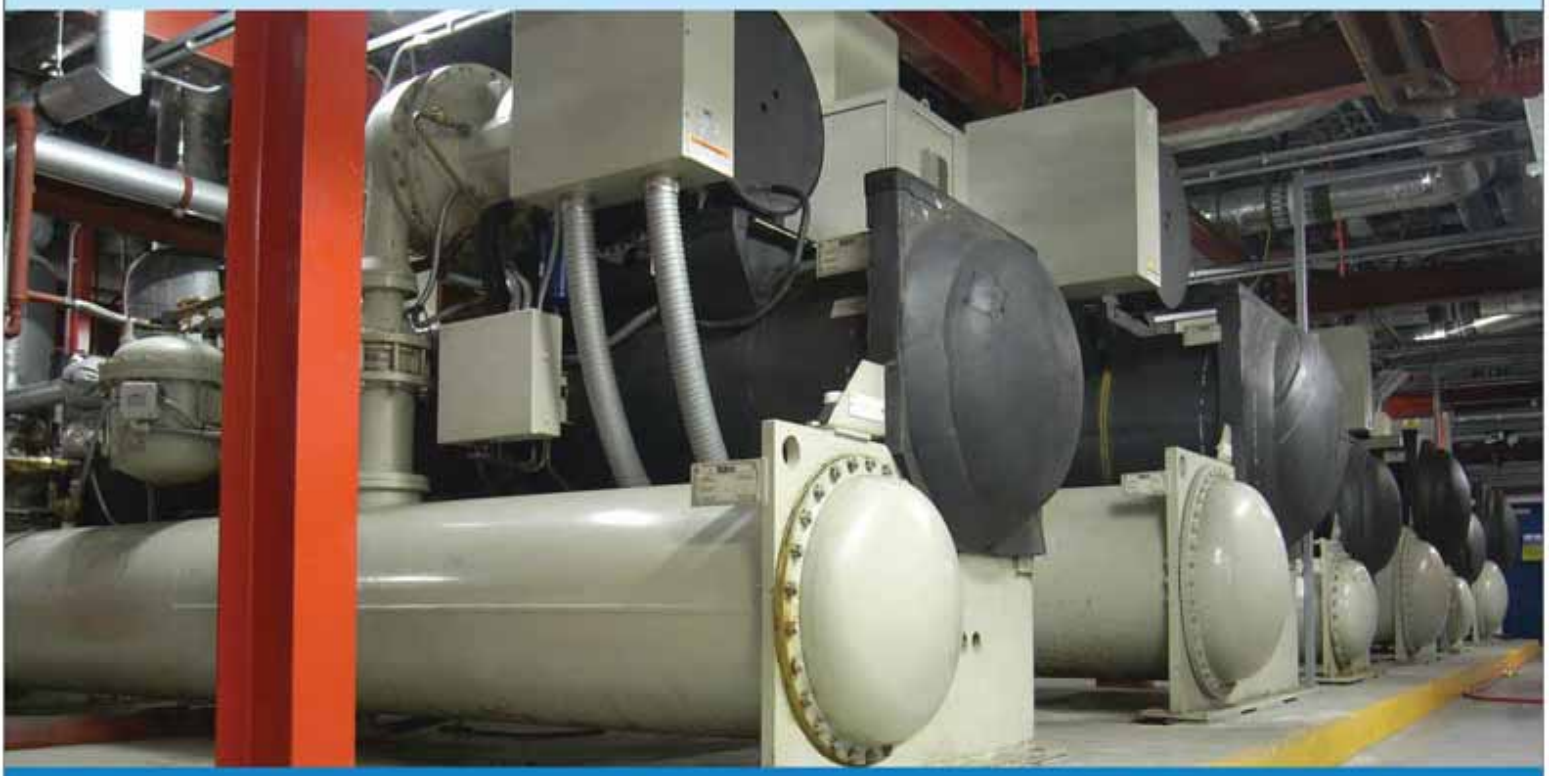

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