



India Chapter

ASHRAE INDIA CHAPTER

For the
HVAC&R
Industry

January-March 2016 | Volume 17 Issue 3

Editor : K.K. Mitra, Associate Editor : Dinesh Rawat | Chapter President : Dr. Rajinder Singh

BULLETIN

Message from the Editor

The year 2015-16 completing its tenure on 30th June. This will be the last Bulletin of this year. The completed year saw number of activities happening, including the flagship annual event AIC Tech in January, 2016, Technical workshops, Student Chapter events, quiz contest, Job Fair etc. Round the clock activities were planned and implemented. In sustainability section a solar powered cold store has been constructed which will now be shifted to a remote village in Uttranchal. YEA members were active and participated in the annual event at GOA. A team of 5 members attended the CRC meet at Istanbul. All ASHRAE Chapter co-ordination meeting was held thrice during the year. AIC hosted Dr. David Underwood, President ASHRAE at Delhi with a breakfast meeting. AIC participated in ACREX 2016 at Mumbai including a Breakfast meeting with ASHRAE President Dr. David Underwood, Mr. Farooq Mehboob DRC and Mr. Basel Anbari, P.E (Nominating Committee). The meeting was attended by all ASHRAE chapter Presidents and President Elects.

Now the new AIC BOG team takes oath on 8th July at India Habitat Centre for 2016-17.

Dr. Rajinder Singh's Classroom

This classroom is started in view to strengthen the theoretical knowledge of Engineers from industries in Refrigeration & Air-Conditioning field. This will also be helpful for the students interested in this field. This will be continuing in our quarterly Newsletter issue. We are starting with some fundamentals of heat transfer and thermodynamics.



Dr. Rajinder Singh
(President-ASHRAE India Chapter)

Fundamentals of Heat Transfer and Thermodynamics for Refrigeration and Air-conditioning Engineers

1.1 TEMPERATURE

Temperature is the thermal potential of a system.



Fig.1.1 Temperature

When a cup of hot tea is left on the table, after some time it cools off and a glass of chilled water eventually warms up. This means when a body is brought into contact with another body, which is at a different temperature (thermal potential); heat is transferred from the body at higher thermal potential to the one at lower thermal potential until both bodies attain the same temperature. At that point, the heat transfer stops, and the two bodies are said to have reached thermal equilibrium.

1.1.1 TEMPERATURE SCALES

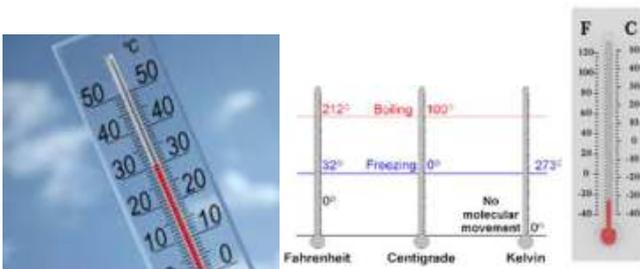


Fig.1.2 Temperature Scales

The temperature scale used in the SI system is the Celsius scale and in FPS system, the scale used is Fahrenheit scale. On the Celsius scale, the ice and steam points are assigned the values of 0°C and 100°C, respectively. The corresponding values on the Fahrenheit scale are 32 °F and 212°F. A more useful temperature scale in thermodynamics is the absolute temperature scale. The lowest attainable temperature on this scale is absolute zero. The absolute temperature scale in the SI is the Kelvin scale which is designated by K. The reading of a thermometer with a Celsius scale, however, will approach -273.15°C. Therefore a temperature of - 273. 15°C

corresponds to an absolute temperature of 0 K. The Kelvin scale is related to the Celsius scale by:

$$T(K) = T(^{\circ}C) + 273.15 \quad (1)$$

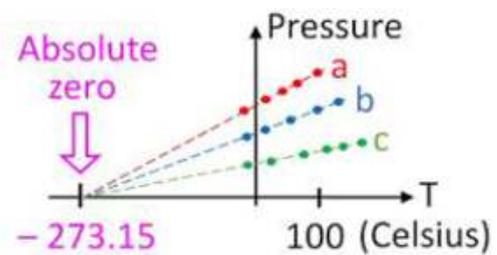


Fig.1.3 Absolute Temperature Scale (The Kelvin Scale)

1.2 HEAT

Heat is a form of energy that flows due to thermal potential difference. That is, an energy interaction is heat only if it takes place because of a temperature difference (thermal potential difference). Then it follows that there cannot be any heat transfer between two systems that are at the same temperature.



Fig.1.4 Heat

Heat has energy units kcal, kJ or Btu. The amount of heat transferred during the process between two states is denoted Q. Heat transfer per unit mass of a system is denoted q and is determined from:

$$q = Q/m \text{ kcal/kg or Btu/lb} \quad (2)$$

TYPES OF HEAT

1.2.1 SENSIBLE HEAT

The amount of heat required to change the temperature of a system without changing its state (phase) is known as sensible heat.

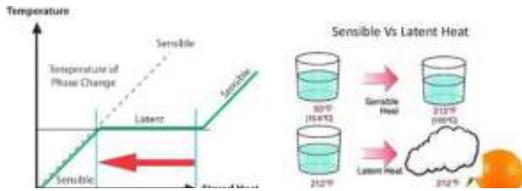


Fig.1.5 Sensible Heat

1.2.2 LATENT HEAT

The amount of heat required to change the state (phase) of a system without changing its temperature is known as latent heat.

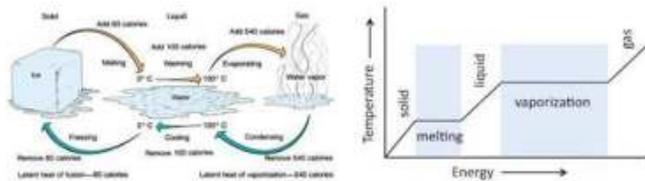


Fig.1.6 Latent Heat

TYPES OF LATENT HEAT

1.2.2.1 LATENT HEAT OF VAPOURIZATION

The amount of heat required to change the state (phase) of a system from liquid to vapour without changing its temperature is known as latent heat of vapourization.



Fig.1.7 Latent Heat of Vaporization

The opposite to that is **latent heat of condensation**, change the state of a system from vapour to liquid state at constant temperature and latent heat is liberated.



Fig.1.8 Latent Heat of Condensation

1.2.2.2 LATENT HEAT OF SOLIDIFICATION (FREEZING)

The amount of heat removed to change the state (phase) of a system from liquid to solid without changing its temperature is known as latent heat of solidification.



Fig.1.9 Latent Heat of Solidification (Freezing)

The opposite to that is **latent heat of melting**, change the state of a system from solid to liquid state at constant temperature and latent heat is added.



Fig.1.10 Latent Heat of Melting

1.2.3 LATENT HEAT OF SUBLIMATION

The amount of heat required to change the state (phase) of a system from solid to directly vapour without changing its temperature is known as latent heat of sublimation. Example is Dry Ice (Solid CO₂) etc.



Fig.1.11 Latent Heat of Sublimation

1.3 INTERNAL ENERGY

The energy of a system itself is known as internal energy of that system.

Internal energy is defined above as the sum of all the microscopic forms of energy of a system. It is related to the molecular structure and the degree of molecular activity and it may be viewed as the sum of the kinetic and potential energies of the molecules. It is denoted by 'U'. The unit of Internal energy is kJ in SI system.

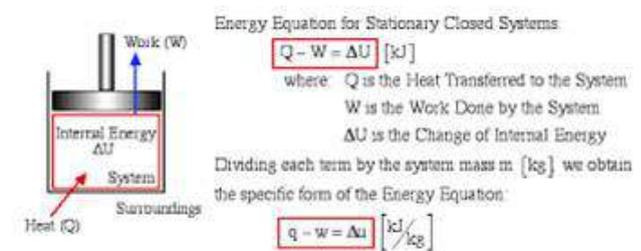
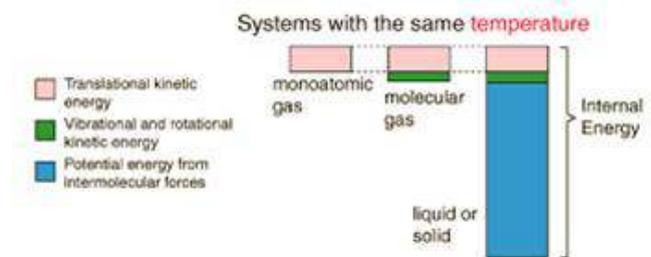


Fig.1.12 Internal energy of a system

1.4 ENTHALPY

Enthalpy is defined as the total energy of a system i.e. sum of internal energy and flow (work) energy. It is denoted by 'H'.

$$H = U + pV \quad (3)$$

Where, U = Internal energy of the system

The unit of enthalpy is kJ in SI system.

The specific enthalpy is denoted by 'h', it is the enthalpy per unit mass and is determined from:

$$h = H/m \text{ (kJ/kg)} \quad (4)$$

1.5 ENTROPY

Entropy is the measurement of disorderness (randomness) of a system. It increases when heat is added, it decreases when heat is removed and it remains constant when no heat is added or removed. It is denoted by change in entropy:

$$dS = dQ/T \quad (5)$$

Where T = Temperature

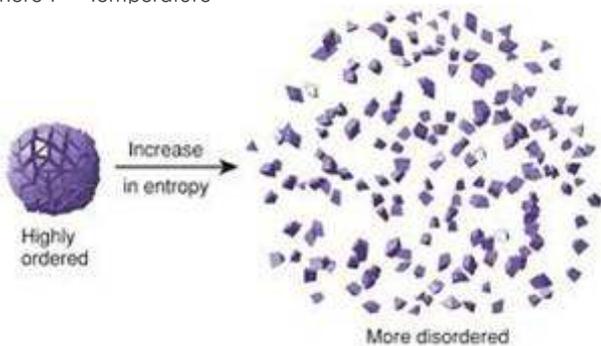


Fig.1.13 Entropy

The unit of entropy in SI system is kJ/kgK.

1.6 MODES OF HEAT TRANSFER

There are three modes of heat transfer:

1.6.1 CONDUCTION MODE OF HEAT TRANSFER

Thermal conduction is a mechanism of heat flow from a region of high temperature to a region of low temperature within medium due to inter molecular activity; this is more predominant in solids. In this case medium is metal itself.



Fig.1.14 Conduction Mode of Heat Transfer

1.6.2 CONVECTION MODE OF HEAT TRANSFER

Convection is the mode of heat transfer between fluid flowing relative to solid surface. In this case medium is fluid. For example air flowing through ducts in air-conditioning applications.

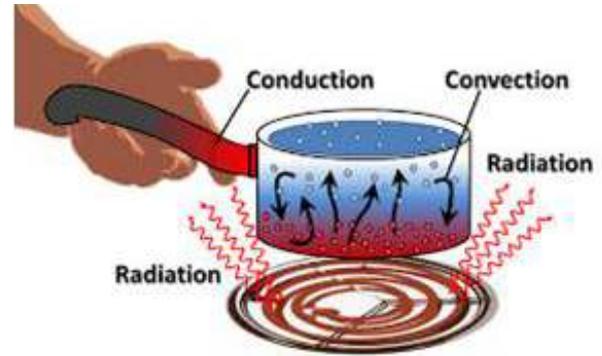


Fig.1.15 Convection Mode of Heat Transfer

Convection mode of heat transfer is of two types:

1.6.2.1 FREE OR NATURAL CONVECTION

If the fluid motion is set up by buoyancy effects resulting from the density variation caused by the temperature difference in the fluid, heat transfer is said free or natural convection.

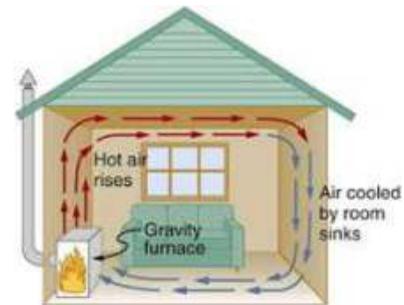


Fig.1.16 Natural Convection Mode of Heat Transfer

1.6.2.2 FORCED CONVECTION

If the fluid motion is artificially caused by means of an external agency like blower or fan. The heat transfer in this case is termed as forced convection.

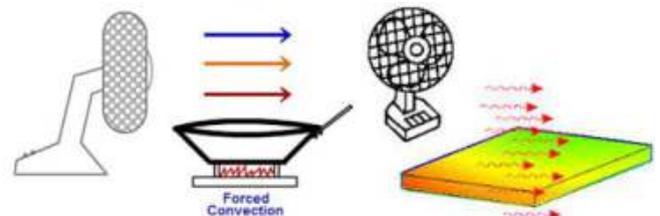


Fig.1.17 Natural Convection Mode of Heat Transfer

1.6.3 RADIATION MODE OF HEAT TRANSFER

Radiation is an electromagnetic wave phenomenon and no medium is required for its propagation. Energy transfer by radiation is maximum when two bodies exchanging energy are separated by a perfect vacuum. The radiations depend upon the temperature and on the optical properties of the emitter.

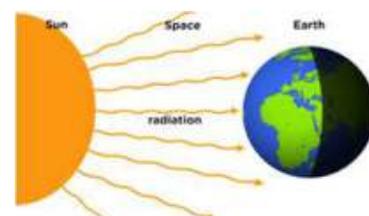


Fig.1.18 Radiation Mode of Heat Transfer

Green Air-Conditioning : A whiff of Fresh Air

Good for Planet, Great for People.

Article by: Air Cmde Kamal Singh AVSM (retd)
Advisor: Campus Planning & Green Initiatives
NIIT University

Green Breathes Life into Air-Conditioning

I recently attended a two-day training program at the CII premises in Gurgaon on 'IGBC's Green Building Rating System' which was impactful in more ways than one. Not only was it engaging and impressive, it also struck a chord with me owing to my own personal experiences.

Of particular interest for me was the IGBC preamble on the Five Elements of Nature (Panchabhutas). The concept resonated strongly with me, thanks to my decade-long experience with deploying these elements at the global NIIT University (NU) in Neemrana, Rajasthan, of which I am a part. The Five Elements of nature, so visible across the NU landscape have made it the institution, it is today.

Having spoken about the Five Elements of nature, I cannot stop myself from sharing, with you readers, the story behind the Green Air-Conditioning revolution that has been unleashed at NU. A pioneering initiative, it has harnessed the power of nature to build a scientific, cost-effective, and sustainable air-conditioning system at the University.

Air-conditioning, as we all know, has proved its worth in India, especially during the harsh summer months when the North of the country is engulfed in heat waves that take a toll on the health and lives of citizens.

At the same time, I would like to underline the fact that while the traditional, and now ubiquitous Air Conditioner (AC), maintains its top place for human comfort, nature does provide other solutions. There are less energy-intensive, so land lower energy-bills and through lowered peak-power make the 'ring' less prone to breakdowns, and also try to improve air-quality obtained in-doors. As a member of ASHRAE—a global society advancing human being through sustainable technology for the built environment—I am sure you are aware and actively promoting many of these options.

At NU meanwhile, we have experimented with a 'fresh-air' design, which has been



planned, executed and reviewed by some of the best architects and master-planners, builders, landscapers and low-energy experts.

Rigorous appraisals were conducted on the design, which when coupled with the experience of living, have led to rewarding outcomes. As an educational institution committed to achieving sustainability, we took a big-leap in working with fresh-air systems. We did this by leaning heavily on the elements of Air, Water and Earth.

This enabled us to usher-in a new paradigm in energy-efficiency. To begin with, the system brought dramatic changes in the Indoor Air Quality (IAQ). For a second, it significantly reduced the carbon footprint of the air conditioning system within NU's precincts, besides delivering several advantages through the following features:

- The use of 'Earth Air Tunnels' as 'front-ends' that 'pre-cooled' the air in the summer-time
- Air Handling Units with Chiller coils that were deployed along with water for 'Sensible' cooling as well as 'Air-washing'
- Mounted ceiling fans in 'work-places' and 'dorms' etc to provide 'Wind-Chill' and deliver comfort
- 'Operable-windows' to welcome outdoor pleasantness
- Building-design that created 'masonry-ducts' to aid air-distribution
- Variable Frequency Drives (VFDs) and Building Management Systems (BMS) that were smartly deployed to improve energy-conservation

Green Air-Conditioning at NU

The HVAC installations at NIIT University are 'fresh-air' systems. NU began its first academic session in 2009, working out of four buildings with an area of about 3.5 lakh square feet. The air-conditioning design was, adopted literally, with a 'bottoms-up' approach. A 'displacement-method' of air distribution was thus chosen, coupled with Earth Air Tunnels. Being a 'purely-residential' Campus, NU has added two more hostels and an additional Dining Hall since the year 2009. There are now seven buildings with a total area of about 7.5 lakh square feet.

With the experience of working and living out of these buildings, we ploughed back the learnings into the system and did things differently as we moved from building-to-building. The advantages, delivered, by special features that I have spoken about, have enabled NU to bring down the tonnage of the required Chillers by half of the capacities, used conventionally.

Working over seasons and playing with Cubic Feet per Minute (CFM)/square feet, it becomes operationally possible to get smarter and reduce the Chiller-hours for the season. Effectively, we now deliver comfort to residents at an energy-consumption which is about 65 percent lower than that achieved by conventional air-conditioning. NU has, additionally realized, a corresponding reduction in its carbon-footprint and Green House Gas (GHG) emissions.

All hostels, offices and classrooms at NU are now greatly benefiting from the fresh-air systems. These systems are serving the NU

Campus, which has been housing about one thousand people for the last two years. The Indoor Air Quality (IAQ) at NU is a class apart and offers learners a distinctly healthier environment.

And this is why. Around 600 ppm of Carbon Dioxide (CO₂) present in outdoor air, at ambient conditions, is allowed to accumulate up to 1130 ppm of CO₂, when the same air is tested in the IAQ, in accordance with IGBC norms. This means a differential of 530 ppm, with respect to the outside measurement of ppm. Compared to this scenario, the CO₂ levels achieved at NU Campus are of the order of 250 ppm at ambient conditions and inside buildings at NU, these remain at 400 ppm! At this point, it would be appropriate to quote, Indian Green Building Council (IGBC) studies, which state that the average daily human consumption of food is 900 grams to one Kilogram, water is five to eight liters and when it comes to air, please hold your breath, it is eight to ten kilograms!

This is important to know because life and breath are inseparable. Vedic knowledge would have us believe that the span of human life is measured by the number of breaths assigned to that life. Therefore, while mankind is plunging more and more into artificially created environments, here is an opportunity to provide superior, healthier and breathable air in our workplaces and even homes.

The sustainable eco-system at Neemrana

As an institution that has deployed best

practices in sustainability, NU has incorporated the Five Elements of Nature on its turf, remaining mindful of their hierarchy, place, position, role and more importantly, their conservation. Prithvi (Earth), Jal (Water), Agni (Fire), Vayu (Air) and Akash (Space or Sky) have received special attention at NU.

A flavor of NU's engagements with the 'Elements' in the local geography are there for all to see. Take the instance of the top-soil, the 'sweet-crust' of the earth, that takes centuries to stabilize and which was being eroded at the Campus by run-off water during monsoons. NU got 14 'Check-Dams' completed and consolidated, between its eastern extent and the Aravalli range. This has helped minimize soil-degradation and significantly contributed to the channelization of aquifers and recharging of ground water.

Over one lakh trees have been planted in government land by NU. The 'carbon-sequestration' being done by these young, mostly local species, has greatly improved air-quality. Treated waste-water is being used for all landscapes, including an ingenious drip-irrigation system for afforestation. Each of these elements are positively impacting the others and exponentially enhancing the benefits.

The trees for example, are improving earth-quality by 'nitrogen-fixing' and 'air-quality' by removing carbon. This improved quality of air is continuously flowing over 7.5 lakh square feet of buildings and enhancing efficiency and productivity, which according to IGBC norms go up by 5 to 15 percent.

The transformational enhancement in biodiversity is further enriching the ecosystem and cleansing the ambient air. Energy efficiency and ecological friendliness, thus, are a natural outcome, at the elemental level.

All in all, NU has underscored the fact that it is possible to harness the power of nature to improve its resources and provide a sustainable infrastructure that replenishes naturally, comforts consistently and benefits everyone who partakes of it.

NU in fact, has set a good example that other institutions can follow, especially at this time when the Government of India has announced that the IITs / Universities will now be allowed to be air-conditioned. As ACs now proliferate across India's leading institutions, it would be worthwhile to make these cooling machines more sustainable and environment-friendly.

It is only in this way that young learners in our universities will be able to, feel those connected moments, and express these sentiments:

"The air in our rooms have a faint fragrance of wet-soil. As I push the window-open, leaning over my study-desk in the hostel room, the chirruping of birds comes alive, with air gushing-in. The monsoons are around the corner and its peak nesting time. Tree crowns sway, in the strong gusting evening winds. Trees, the eternal givers of life, seem to be rejoicing and bending over, playfully making way for the wind. Hundreds of trees, that are swaying in harmony, are capturing our hearts and minds. There is faith, hope and joy in the air".

Chapter Activities



Department of Mechanical Engineering, DCR University of Sc. & Technology Murthal organized a one week Faculty Development Programme on "Current trends in HVAC&R" from Feb 8-12, 2016. On behalf of Ashrae India Chapter technical presentation where given by Sh Dinesh Gupta, Dr Rajinder Singh, Mr K K Mitra, Sh. Rahul Aeron.



Technical workshop held on 28th April-2016 at Jamia Millia Islamia Dr. Rajinder Singh gave a Presentation on "Scope Of Refrigeration & Air Conditioning in India 'to faculty and students present. Awareness about ASHRAE Membership benefits to student was created among the student present.



ASHRAE India Chapter organized its first independent JOB FAIR cum Industrial Training Fair for recruitment of 'ASHRAE India Student Chapters' students and selection of students for Industrial Training at AMITY UNIVERSITY, NOIDA on 30.04.2016.

Chapter Activities....



Breakfast meeting with ASHRAE President, Mr. David Underwood was held on 21st Feb., 2016 at Hotel Claridges. Dr. Rajinder Singh, President, Mr. K.K. Mitra, President Elect., Mr. Priyank Garg, Secretary, Mr. U S Jadon, Chair Student activities and Mr. Dinesh Rawat, Coordinator were present. Mr. David Underwood appreciated the activities being held by the chapter.



Training Program on "Design and Simulation of Radiant Cooling Systems" was held on 16-17 March 2016 at Epicentre, Sector 44, Gurgaon in association with BEEP, BEE & DCI. Mr. PIERRE JABOYEDOFF, Senior Engineer and Energy Consultant, Partner in Effin'Art Sarl. was the main trainer.



A Technical workshop on 'Basic Refrigeration & Air-Conditioning and Automotive Air-Conditioning' was successfully held at University of Petroleum and Energy Studies (UPES) DEHRADUN on 15th April, 2016, well appreciated by Students and Faculties.



The Installation of ASHRAE Student chapter at DEENBANDHU CHHOTU RAM UNIVERSITY OF SCIENCE AND TECHNOLOGY (DCRUST), MURTHAL, SONIPAT (HARYANA) was done on 23rd April, 2016,.



ASHRAE India Chapter supported MANFEX 2016 held during 17th-18th March, 2016 at Amity University, Noida.



ASHRAE Student Chapter was installed at Aligarh Muslim University on 29th March, 2016.



Student Quiz Contest was organised by ASHRAE India Chapter on 31st March, 2016 at Amity University, Noida. Students from the following five institution participated in the Quiz contest.

- Poornima College of Engineering • Amity University, •Thapar University •DCRUST, Murthal • Aligarh Muslim University

Program on Industrial Refrigeration on 4th June 2016 at Thane.

A program on 'Industrial Refrigeration' was organized on 4th June 2016 at Hotel United 21 in Thane under the auspices of ASHRAE Mumbai chapter and ISHRAE chapters of Mumbai and Thane. It was a first of a kind program on this topic and was initiated to address an area of interest hitherto not taken up for discussion. Most programs in the past have been on comfort air conditioning and cold chain with respect to refrigeration.

The program was supported by International Institute of Ammonia Refrigeration (IAR), Association of Ammonia Refrigeration (AAR), Refrigeration and Air conditioning Traders Association (RATA) and Indian Association of Energy Management Professionals (IAEMP). The Table partner for this event was Messrs. FX Multitech Pvt. Ltd.

- Dr. Rajinder Singh, President ASHRAE India Chapter has been selected by the ASHRAE CTC as an ASHRAE Distinguished Lecturer effective July 1, 2016.
- Dr. Rajinder Singh President and Mr. KK Mitra, President Elect. attended the Chapters coordination meeting held on 28th May, 2016 at Chennai.
- Department of Mechanical Engineering & Applied Science, Poornima College of Engineering organized a National Seminar on "Innovative Green Technologies for Sustainable Sanitation, Health & Environment" (IGTSHE - 2016) on April 22, 2016. Mr. K K Mitra, President Elect. attended the event of behalf of Ashrae India Chapter.
- The making of 'Solar Cold Storage' of two cubic meter size designed by Dr. Rajinder Singh under ASHRAE India Chapter's Sustainability Programme has been completed successfully and this Solar Cold Storage will be installed in village Mali Gabini (Uttarakhand).
- Department of Mechanical Engineering, Poornima College of Engineering, Jaipur organized a Visit of Solar Power Plant at J.B. Fashion, Sitapura, Jaipur on April 07, 2016 in association with ASHRAE India Chapter.
- ASHRAE Jaipur Section with India Chapter arranged a Industry visit for our Student Chapter and YEA members of Poornima College of Engineering on 4th Feb., 2016 at Carrier Refrigeration.
- Dr. Rajinder Singh, President ASHRAE India Chapter has signed a collaboration of ASHRAE India Chapter for "International Conference and Exhibition on BUILDING UTILITIES" to be held during 1st-3rd DECEMBER 2016 being organized by Jamia Millia Islamia, New Delhi.
- ASHRAE Student Chapter in IIT Delhi: Ten membership forms from students have been received and sent to ASHRAE USA and in near future we will install ASHRAE Student Chapter in IIT Delhi.

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