ASHRAE India Chapter

ASHRAE INDIA CHAPTER BULLETIN

For the HVAC&R Industry

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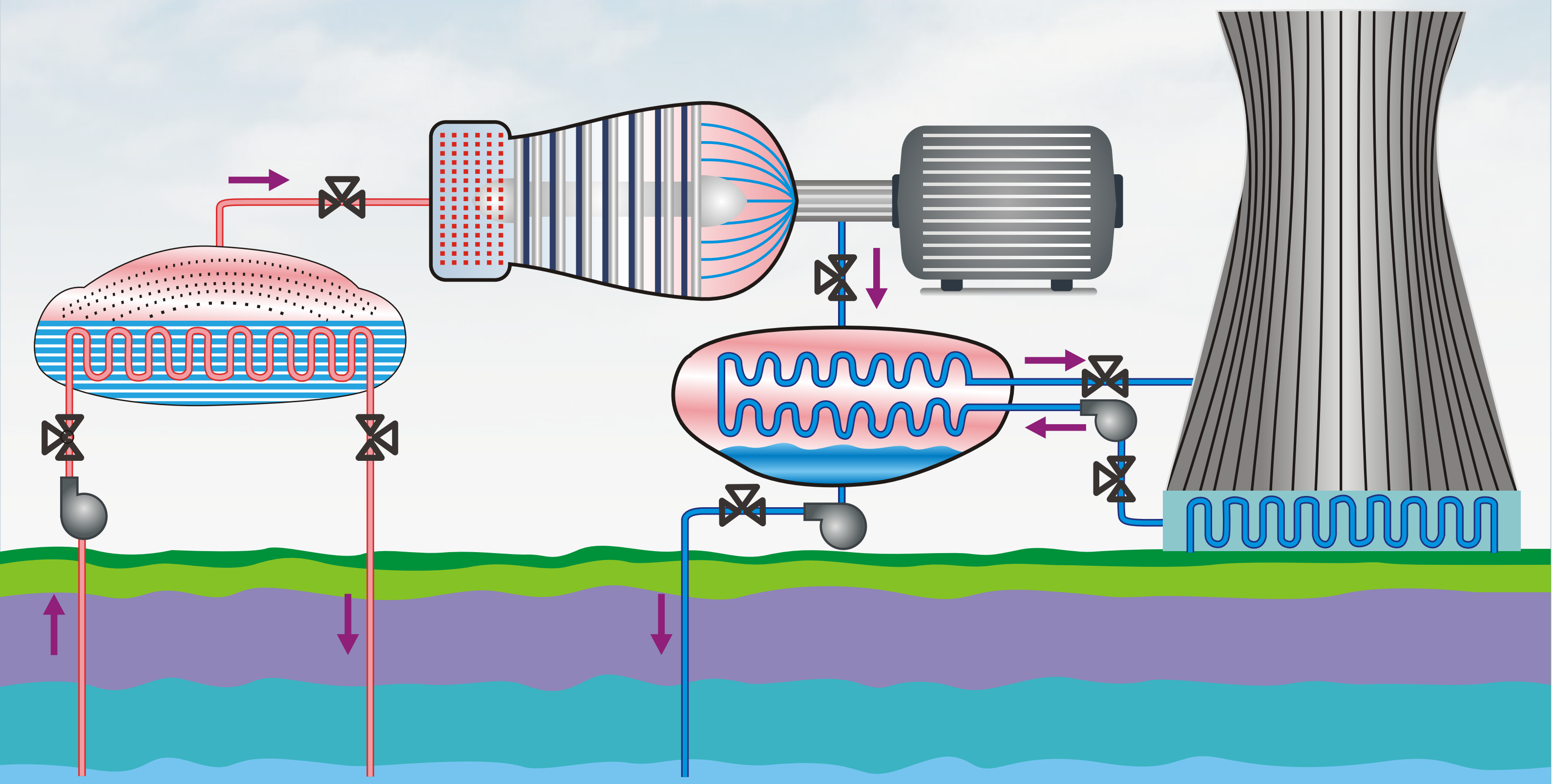
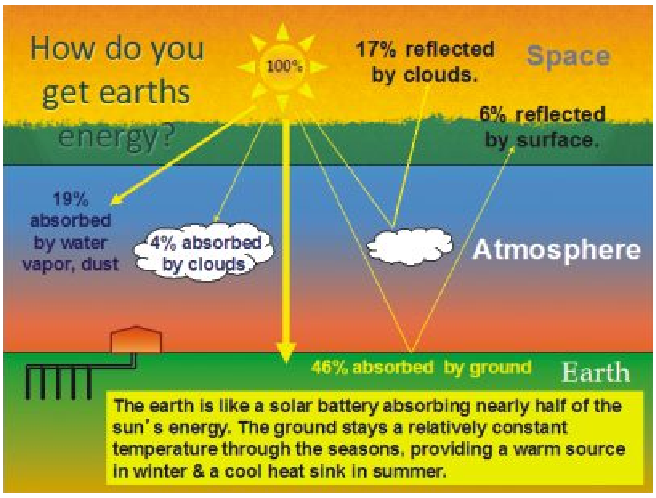
Editor : K.K. Mitra, Associate Editor : Dinesh Rawat | Chapter President : Sunil Kher

GEOTHERMAL

THE RELIABLE RESOURCE



GEOTHERMAL – COOLING AND HEATING

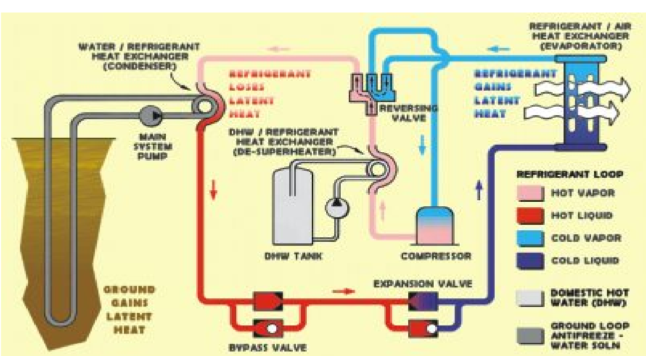


1.1 INTRODUCTION

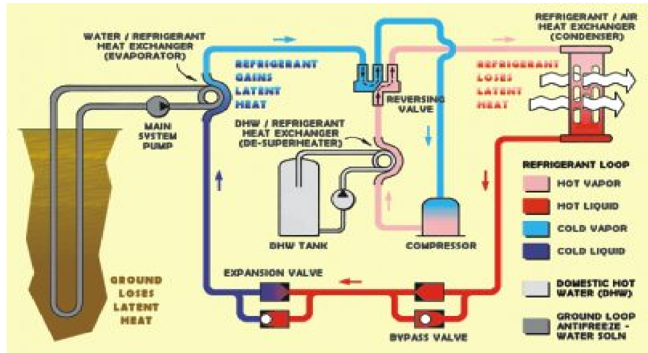
Say "solar energy" and most people think of solar collectors on rooftops. The best solar collector around, however, is the earth itself. Ground source heat pump (GSHP) systems—also known as earth coupled, geothermal or Geo Exchange — use the earth and the solar energy it collects to help meet our heating, cooling and water heating needs. From the solar energy earth absorbs and stores, the earth stays at a relatively constant temperature all year round. Rather than creating heat, a GSHP system moves heat from the earth into your house in the winter and from your house back into the earth in the summer. This demonstrates how GSHP systems work and answers common questions about the systems.

This is a system where free energy from the earth is used for cooling and heating in summers and winter. The temperature below the earth is almost constant. A ground source heat pump system consists of one or more heat pumps connected to a ground heat exchanger (GHX). In warmer months, the ground acts as a heat sink, allowing heat to be rejected to the ground; similarly, in cooler months, the ground can be a source of heat as heat is extracted from the ground. Thus, heat can be extracted from and rejected to the ground on a cyclic, annual basis. This cycle can last for many years, as equipment can be replaced as it ages; the limiting factor in the lifespan of a GSHP (Ground Source Heat Pump) system is typically either the durability of the HDPE piping that comprises the GHX, or the functional life of the building itself.

COOLING MODE



HEATING MODE



1.1.1 Typical Equipment for GSHP system

GSHP systems consist of three parts:

- The ground heat exchanger
- The heat pump unit
- The air delivery system (ductwork).

In the winter, the GSHP removes heat from the ground heat exchanger and pumps it into the indoor air delivery system. In the summer, the process is reversed and the GSHP moves heat from the indoor air stream into the ground heat exchanger. Ground heat exchangers for GSHP systems consist of a grid of buried polyethylene plastic pipe (ground loops) through which a liquid heat exchange solution circulates. This circulating fluid is the mechanism by which heat is absorbed from the earth for delivery to the indoor distribution system. As heat is removed from the circulating fluid by the GSHP, the warm earth replaces this energy.

1.2 TYPE OF GEOTHERMAL SYSTEMS;

Ground Loop

There are four main kinds of ground loop systems to choose from:

- Horizontal loop,
- Vertical loop,
- Pond/lake / Sewer loop
- Open loop.

The one you install will depend on your specific needs, climate and soil conditions, available land area and the local installation costs. The same loop works for both heating and cooling

Horizontal, vertical and pond/lake/sewer loops are all closed-loop systems. The heat pump and loop form a sealed, pressurized system through which the liquid heat exchange medium is circulated. Open-loop systems, on the other hand, are not sealed, and are open at either end to obtain the liquid heat exchange medium (water) from an existing well or surface body and to discharge it externally, as well.

Horizontal, vertical and pond/lake loops are laid horizontally in trenches or vertically in boreholes. Both are placed in an area adjacent to the buildings they serve; systems can go in yards or under parking lots, driveways or playing fields. Any area with appropriate soil conditions and adequate square footage near a home or business will work. The design used depends on available space, but neither design is superior to the other.

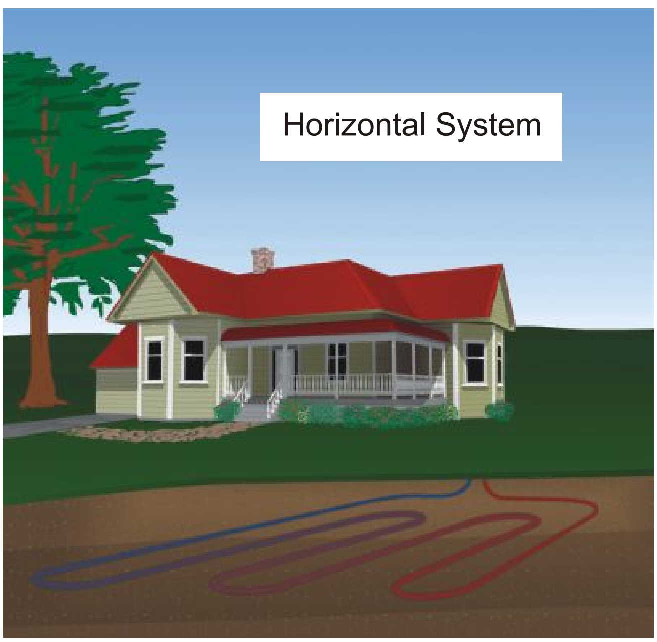
Pond/lake/sewer loops require a nearby pond or lake or sewer of sufficient depth in which to put the loops. Open loops require adequate water for the needs of the system.

Your geographic location will determine how deep the pipe is buried and whether, in a closed-loop system, an antifreeze solution is necessary. Ground temperature varies with locations and ambient climatic conditions. In cooling dominated climates, the depth of the pipe should be four to six feet (the closer to six feet, the better) to reduce efficiency losses in the late summer due to drying soils. In heating-dominated areas, the depth may be reduced four to five feet. This reduces trenching costs but requires the use of antifreeze in the loop to prevent freezing in the winter. Several antifreeze solutions are available for GSHP systems (propylene glycol, etc.). Antifreezes should be biodegradable and present no hazard to the environment. A 20 percent solution is usually adequate. Proper mixing requires the use of a 20 to 30 gallon container with a separate pump. All pipes should have the minimum cell classification number imprinted on the pipe. PVC pipe should never be used in the underground portion of the system. Proper pipe correctly installed will last more than 50 years. To create closed-loop systems, pipe and fittings are connected by butt or socket fusion (heat fusion) or stab fittings. Barbed fittings and clamps should not be used as they result in potential leaks and joint failure when used with high density polyethylene pipe.

1.2.1 HORIZONTAL LOOP

For a horizontal ground loop system, a network of trenches is cut by a trencher or backhoe. One to four pipes are laid horizontally in the trench, at least four feet deep depending on the thermal conductivity test (TC Test). The pipes are pressure tested, then connected to the heat pump inside the building. The trenches are backfilled. The amount of piping necessary depends on the heating and cooling load calculation (heat loss/ heat gain) for the building.

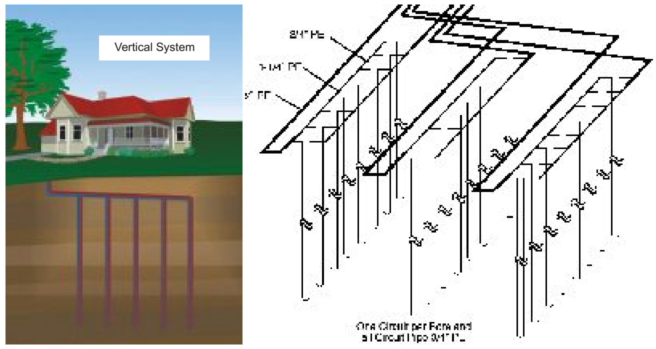
The most common horizontal layouts make use of two pipes: one at six feet and one at four feet in a narrow trench, or two pipes placed side-by-side at five feet in a two-foot wide trench. A relatively new configuration of looped pipe, called the Slinky™, makes it possible to fit more pipe in shorter trenches, reducing installation costs and making horizontal loops feasible in locations with limited area



1.2.2 VERTICAL LOOP

For a vertical ground loop system, multiple boreholes (about four inches in diameter) are drilled 10 to 15 feet apart and 100 to 400 feet deep depending on the thermal conductivity test (TC Test). Two separate pipe lengths are connected with a U-bend to form a loop, then placed in each borehole and pressure tested. The borehole is backfilled with a grouting material and sealed off at the surface,

Vertical loops are tied together with a system of horizontal piping laid in trenches, then connected to the heat pump in the building. Again, the amount of piping and the number of boreholes required depends on the heating and cooling load calculation for the building.

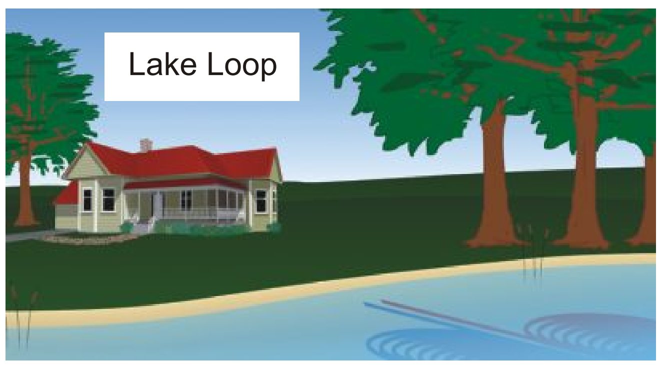


1.2.3 POND/LAKE/SEWER LOOP

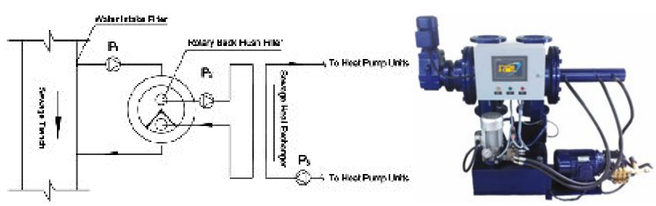
Pond/lake/sewer loops depend on the location of a pond or lake or sewer near the building. Pond loops are less expensive to install.

Loop coils should never be placed in a river or a body of water where fluctuating water levels or flood stage conditions could damage the pipe. Pipe is coiled in a fairly large body of water, at least eight feet deep to prevent freezing

A supply line buried in a trench runs from the building to the submerged loop; the pond or lake must be fairly close to the building or this supply line will provide the same heat transfer function as a horizontal ground loop.



SEWAGE SYSTEM

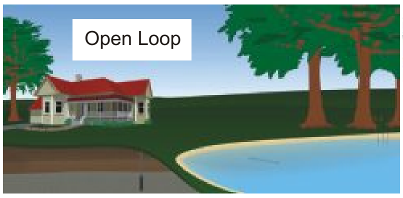


1.2.4 OPEN LOOP

In an open-loop system, a well or a surface body of water supplies the fluid that circulates through the GSHP system. Once it has circulated through the heat pump, the water is returned to the ground through one of several methods: a recharge well, a drain field or surface discharge.

This option should only be used where an adequate supply of water is available. A good rule of thumb is as least three gallons per minute for each ton of heating and cooling. During extremely hot or cold weather, the water source must be able to handle the needs of a heat pump running continuously.

The discharge method must also be able to handle an increased capacity during extreme weather conditions. Local codes and regulations should be followed at all times.



1.3 GROUND SOURCE HEAT PUMP PAYBACK

The higher efficiency of GSHP systems means the expense of heating your home or business may be reduced by as much as 40 percent when compared to fuel oil, natural gas or propane, and 60 percent when compared to electrical resistance heat. Cooling costs are reduced by 25 to 30 percent compared with the best new air conditioners and by 40 to 50 percent compared with older units. Include the benefits of a built-in desuperheater for hot water savings of 65 to 70 percent compared to conventional water heaters, and you have the most efficient system available GSHP systems cost more initially than conventional systems, but the investment requirement, unlike other projects, produces an attractive annual savings and payback, and increases the value of the home. A typical payback period is three to five years. Your savings compound with the proven reliability and long life of GSHP systems.

1.4 THERMAL CONDUCTIVITY

1.4.1 Confirming geological assumptions

Feasibility assessment allows designer to optimize building & systems to work effectively with GHX. Optimized building loads allow designer to develop smallest GHX based on geological information. Assumed geological information may need to be confirmed to finalize GHX design.

1.4.2 THERMAL CONDUCTIVITY

Thermal conductivity (TC) is a measure of how much energy can be transferred through the soil or rock surrounding the GHX:

- Unit of measure – W / (M* K)
- Ranges from about 0.50 (low density clay) to 3.80 (dense rock) W / (M* K)

1.4.3 THERMAL DIFFUSIVITY

Diffusivity is a measure of the speed at which energy moves through soil or rock surrounding the GHX:

- Unit of measure – M2 / day
- Ranges from 0.03 (light dry soil) to 0.140 (dense rock) M2 / day

Diffusivity is estimated by reviewing the borehole log and estimating the diffusivity based on the type of soil. Diffusivity could be measured only by knowing the exact distance of a temperature probe from the heat source and measuring the length of time till the temperature difference is measured.

1.4.4 GHX TC test equipment

Thermal conductivity test for vertical or Horizontal borehole consists of:

- Determining the ambient deep earth ground temperature
- Injecting heat into borehole at known rate (Btu/hr or kW
- Determining the ΔT between fluid entering & leaving the GHX
- Calculating thermal conductivity using the Line Source Method

1.4.5 Thermal conductivity unit consists of:

- Circulation pump
- Electric elements
- Entering & leaving water temperature sensors
- Data logger
- Power supply for electric elements

1.4.6 Typical TC test results

A typical TC Test report shows the entering and leaving water temperatures from the U-tube, as well as energy input. Data is typically logged in 1 to 5 minute intervals for the duration of the test. ASHRAE recommends power input of 50 to 80 Watts per meter of borehole.

1.4.7 Depth of test borehole is important

A TC test measures the average conductivity of the entire borehole. If the test borehole is not the same length as the actual finished GHX, the average TC can be significantly different in the 2 boreholes and the system may not perform as anticipated

1.4.8 Vertical GHX - installing the test borehole

Locating test borehole to permit use in future GHX field & using pipe size that will be specified helps reduce cost of test. Test borehole often completed before construction of project and should be protected accordingly. The test borehole should be drilled to the depth required in the final GHX design.

1.4.9 Vertical GHX - grouting test borehole

Adding thermally enhanced grout to test borehole does not change conductivity of the formation. It only changes the temperature the borehole operates at. Data from the first 8-12 hours of a TC Test is not used to calculate conductivity...only data after the initial start-up period is used to determine conductivity.

1.4.10 Allow ground temperature to stabilize

Drilling process adds energy to formation & increases temperature of the borehole. It can also alter the moisture content. Moisture & energy must dissipate into the formation & return to normal conditions. This takes 4-5 days. A TC Test should begin after the ground returns to normal temperatures.

Frequently Asked Questions - FAQ

- **What are the advantages and disadvantages of the horizontal and vertical installations, respectively?**

  Horizontal installations are simpler, requiring lower-cost equipment. However, they require longer lengths of pipe because of variations in soil temperature and moisture content and installations can be adversely affected by extensive rainy weather. A larger area is usually required. Extensive hard rock may dictate a vertical installation, which requires highly trained operators for the drilling machines but less pipe. Where land is limited, vertical installations or a compact SlinkyTM (horizontal installation) can be ideal.

- **Will an underground loop affect my lawn or landscape?**

  No. Research has shown that loops have no adverse affect on grass, trees or shrubs. Most horizontal installations require trenches about six inches wide, while vertical loops require little space. Temporary bare areas can be restored with grass seed or sod.

- **My yard contains many shade trees. Will this affect ground temperature and my ability to use it as an energy source?**

  Not at all.

- **Does an operating GSHP system make much noise?**

  With no exposed outdoor units, GSHP systems provide a calm environment outside and operate quietly indoors.

- **Are there any safety hazards associated with GSHP systems?**

  Because they have no combustion process, GSHP systems are safe. Systems do not risk producing explosions, carbon monoxide poisoning or fires like their conventional counterparts.

- **What are the environmental benefits of GSHP systems?**

  GSHP systems conserve energy and reduce the amount of toxic emissions in the atmosphere. They use renewable energy from the sun, and because systems don't rely on outside air, they keep indoor air cleaner and free from pollens, outdoor pollutants, mold spores and other allergens.

Geothermal system benefits and intangibles summary

- **Environment**
  - –IAQ Friendly: Increased latent capacity improves humidity control vs. RTUs
  - –No water treatment: Water resource not required
  - –For every hour of use, a Geoexchange system produces one pound less CO_2 than a conventional HVAC system.
  - –No on-site combustion, no carbon monoxide
- **Efficient/ Reliable**
  - –30-45% less energy cost annually
  - –Performs both cooling and heating efficiently
  - –Bore field 50+ year solution
  - –Single unit failure does not affect the rest of the system
- **Economical**
  - –Less first cost than Central Plant
  - –Competitive option for retrofit projects
  - –No water resource required – closed loop system
  - –No exterior equipment
  - –No vandalism, hail/sun damage or roof leaks
  - –Maintains roof/ envelope integrity
  - –Low parts and labor costs,
  - –No Annual On-Call fees
- **Functional**
  - –Simple individual space control
  - –Dedicated unit/ pump per Zone
  - –Flexible Design: Single building or entire campus; single level building or multi-story building
  - –Flexible construction for future renovations/ additions/ internal spatial changes

Acknowledgment - International Ground Source Heat Pump Association – IGSHPA

By: Mr. Richie Mittal

Workshop on Green Rating Certification

With the growing demand for Green Building, there is a need to enhance the knowledge of building professionals on Green Building Concepts and equip them on the Green Building Rating System. In continuation with ASHRAE India Chapter(AIC) initiative for dissemination of knowledge to industry, AIC is conducting a full day workshop on Green Building Rating Systems on 29th May, 2015 at The MAPLE, India Habitat Center, Lodhi Road, New Delhi.

1. Full Day Workshop on Green Rating Certification on 29th May, 2015 at The Maple, India Habitat Center, Lodhi Road, New Delhi - 110003
2. The Annual General Meeting and installation ceremony of the new BOG (2015-2016) elected to serve ASHRAE India Chapter for the year 1st July, 2015 to 30th June, 2016 will be held on 4th July, 2015 from 6.30 PM onwards. Venue for the AGM is Magnolia, India Habitat Centre, Lodhi Road, New Delhi - 110003

News Paper Coverage

Published in Dainik Bhaskar on Mar 24, 2015

स्टूडेंट्स ने जाने वेंटिलेशन के डिफरेंट स्टैंडर्ड्स

सिटी रिपोर्टर • वेंटिलेशन द वंस एंड फ्यूचर किंग विषय पर सोमवार को पूर्णिमा कॉलेज ऑफ इंजीनियरिंग में वर्कशॉप आयोजित की गई। अशरे और इशारे चैप्टर की ओर से आयोजित इस वर्कशॉप में यूएस की लॉरेंस बार्कले नेशनल लेबोरेटरी की सीनियर साइंटिस्ट मैक्स शेरमन ने स्टूडेंट्स को विषय के बारे में जानकारी दी। अशरे इंडिया की कॉर्डिनेटर दिनेश रावत और पीसीआई कैंपस ओ.पी. शर्मा ने शेरमन का स्वागत किया। इस वर्कशॉप में कॉलेज के 150 स्टूडेंट्स शामिल हुए।

ACRECONF India 2015






Delhi Chapter of ISHRAE and ASHRAE India Chapter jointly organised the 14th edition of its annual Conference ACRECONF India 2015 on March 20 & 21, 2015 at India Habitat Centre in New Delhi. The event attracted best minds from all over the world to debate the burning topics in Building Services sector and also provide platform for networking. The Conference gained particular importance this year keeping in view of our Prime Minister vision for "Make in India" as well as reforms in Reality sector. ACRECONF India 2015 theme was titled "360 Degree View on Emerging Mega Trends in Built Environment" and six parallel sessions were held each day.

Hi-Aim: Hospitality Industry-Architecture, Interiors and Management

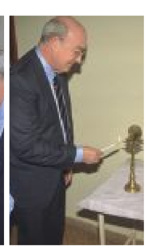
The 4th annual Hi-Aim Conference took place on 26th-27th March 2015 at The Leela Ambience Gurgaon. The Conference was witnessed and welcomed by more than 200 delegates from the Hospitality Sector which aimed at bringing together the top notch industry experts to share their views and visions. ASHRAE India Chapter was Associate Partner for the conference.

ASHRAE Workshop

ASHRAE India Chapter organised a workshop on 'Equipment Design Evolution & Data Center Operation Optimization using ASHRAE's Guidelines' on Saturday, 21st Feb, 2015 at Paharpur Business Centre & Software Technology Incubator Park, Nehru Place, New Delhi . The speakers at the interactive workshop were the ASHRAE Distinguished lecturers Mr. Don Beaty and Dr. Roger R. Schmidt. The partners for the event were Swegon Blue Box Pvt. Ltd. and Bry-Air Asia Pvt. Ltd.

Distinguished Lecture Programme

ASHRAE India Chapter and ISHRAE Jaipur chapter jointly organized the distinguished lecture at Poornima College of Engineering, Jaipur on March 23, 2015. Dr. Max Sherman delivered the lecture on ***Ventilation: The Once and Future King***. He focused on the importance of ventilation in Buildings. During his presentation he shared about his knowledge about Ventilation, its function, requirements, ventilations standards and role of ventilation in buildings. In this event Mr. Dinesh Rawat (Coordinator ASHRAE India), Dr. Om Prakash Sharma (Director, PCE), Mr. Shailendra Kasera (HOD, Mechanical Engineering, PCE) along with 25 faculty members and 150 students were present. Dr. Sharma delivered the word of blessing and emphasized that this is a good platform of sharing the knowledge between the ASHRAE and our students. At the end, Mr. Shailendra Kasera delivered the vote of thanks to all dignitaries and participants.



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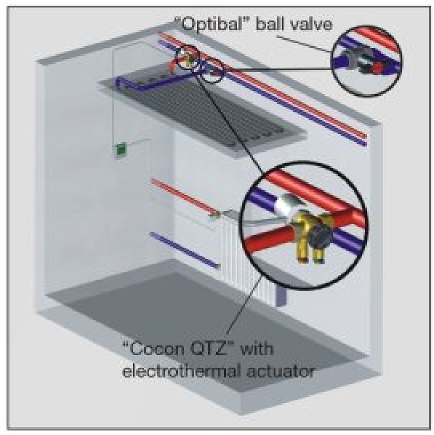

Chilled ceiling system

The Oventrop pressure independent dynamic balancing valve "Cocon Q" combines two hydronic functions in one valve.

Firstly, in connection with standard actuators or thermostats (M 30 x 1,5), the valve controls the flow rate depending upon the room temperature requirements.

Secondly, the maximum flow rate, when the valve is fully open, is automatically controlled, ensuring that the maximum required flow rate in all supply risers is not exceeded.

Your advantage:

- multifunctional applications (e.g. chilled ceilings, fan coil units, air handling units, convector and central heating systems)
- presetting and optical display of the nominal values even with mounted actuator

For further information please contact:

Mr. Sunil Anand
Dehli, India
Phone (+91) 1 20 - 2 59 13 19
Mobile (+91) 99 71 66 46 90
E-Mail s.anand@oventrop.com
or:

Mr. Milind Pawar
Mumbai, India
Mobile (+91) 98 33 83 08 37
E-Mail m.pawar@oventrop.com