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External view of Grand Hyatt Mumbai.



Absorption chiller in the plant room of Grand Hyatt Mumbai.
Photo courtesy of Grand Hyatt Mumbai.

Six Key Steps in Hotel HVAC Design

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The hotel industry in India has matured over the last 10-15 years, become increasingly sophisticated and capable of meeting the needs of the most discriminating users and businessmen from all over the world. International hotel chains have also entered the country bringing with them their design standards and years of operating experience to further enhance the industry.

This article makes an attempt in identifying the many facets of engineering design which contribute in building the industry. HVAC design plays an important role in the overall design, since energy alone consumes about 8 per cent to 12 per cent of the revenue generation (HLP in hotel terminology or Heat, Light and Power)

There are many key steps in designing an HVAC system for a hotel, of which the following six key steps help in shaping the optimum design:

- Energy conservation
- Water conservation
- Indoor air quality
- Fire safety
- Pollution control
- Space planning for plant & equipment

Energy Conservation

Selection of the following individual components plays an important role in energy conservation for a hotel project:

Chilling Unit. The type of chilling units generally selected are screw, centrifugal or absorption for larger installations. Reciprocating chilling units are seldom selected unless the installed capacity is very small and does not warrant selection of a screw chilling unit. Watercooled chilling units become most economical in terms of I kW/TR , compact installation and longer life. The I kW/TR for screw and centrifugal chilling units varies between 0.55 to 0.7 as per the specified fouling factors and size of chilling units. The selection and usage of absorption chilling units becomes viable in areas where piped gas (PNG/LPG) is available and electric supply is either very expensive and/or has frequent interruptions. The direct gas fired absorption chilling units in combination with screw or centrifugal chilling units become a strong candidate for very large hotels particularly with time of the day (T.O.D) power supply tariff. A special gas tariff for absorption chilling units by Mahanagar Gas Ltd. in Mumbai makes the combination most effective in terms of operating cost. The current design practice is to select chilling units for a larger ΔT of 10°F (5.5°C) on the chilled water as well as on the condenser water circuits so as to minimize pumping costs and also reduce the chilled water and condensing water pipe sizes.

Pumping System. Conventional pumping systems in a chilled water circuit with a fixed flow rate, have been common all these years and are still selected in smaller

installations since they are cost effective. However, larger installations are selected with a variable speed pumping system (VSPS) for most effective reduction in operating costs.

A typical hotel can be divided into four possible operational zones based on the hours of usage of individual areas namely: *guest rooms, lobby + all day dining + back of the house, banquet halls + meeting rooms, and specialty food & beverage outlets*. The 'VSPS' is a combination of fixed flow rate primary chilled water pumps and variable frequency drive secondary pumps which may be extended to tertiary pumps on very large installations with extensive piping distances.

The selection of a pumping system coupled with the most efficient model of pump and motor based on pump curves becomes a crucial factor for minimizing operating costs.

Cooling Tower. A variable frequency drive on the cooling tower, controlled through the basin water temperature, during non-peak hours, has proved to be an effective tool in energy conservation.

Air Handling Unit (AHU). The double skin AHU with variable frequency drive and heat recovery wheels, particularly in high occupancy areas like banquet halls and meeting rooms, is instrumental in large energy savings.

Car Park Exhaust Fan. The National Building Code calls for 30 air changes per hour for basement car park exhaust system during fire mode, and 15 air changes per hour for normal mode for minimizing carbon monoxide levels. As per experience, it is most economical to use two separate fans and duty-cycle the normal exhaust fan as per preset limit of carbon monoxide level.

Automatic Capacitor Bank. Effective selection of automatically operated capacitor banks of small denomination (say 2–5 KVAR) on all inductive loads of the HVAC system, improves the power factor to near unity, thereby resulting in large savings of operating cost.

Building Automation Systems (BAS). The BAS, integrating, controlling and monitoring of all the HVAC equipment is the most modern and ultimate tool towards energy conservation with minimum human errors.

Water Conservation

Water-cooled chilling units require a large quantity of make-up water for cooling towers. The water requirement in general for functional usage such as bathing, cooking, washing, flushing, laundry, boilers, etc. for a hotel is also very large. It is always a challenge to the operating chief engineer to maintain the quantity and quality of various primary functional

water needs of various departments. The water for cooling tower make-up in such a case becomes a secondary functional requirement. Municipal Corporations in practically all parts of the country have banned the use of municipal water for air-conditioning makeup. They only provide water for the primary functional needs of the hotel, as described above.

Hence, the source of water for the HVAC system cooling tower makeup has to be either from borewell treated water, tanker treated water or from sewage treatment plant (STP) treated water. The first two sources are not under the control of the operating chief engineer and become effective only when good quality of water with enough yield is possible for the particular installation. The STP then becomes the most effective and the only dependable source of water for HVAC system cooling tower make-up. The generation of sewage, sullage, backwash from filters, waste water from kitchens and laundry are the major sources in a hotel and a good candidate for generating make-up water for the HVAC system to cooling towers, through STP. The quantity and quality of water generated through STP for most hotels, is large enough for meeting the needs of make-up water for the HVAC system cooling towers as well for horticulture. This water with proper treatment is generally also used for flushing of the hotel toilets.

Indoor Air Quality (IAQ)

IAQ is vital to hotels and the terminology is well known to hotel guests. The consistency in maintaining IAQ is very important in terms of maintaining hotel classification and also to have repeat - guest business.

The amount of fresh air for various usable areas of the hotel is specified as per ASHRAE IAQ Standards, and is the acceptable norm throughout the hotel industry.

The location and size of fresh air inlets and exhaust outlets and keeping them apart at a safe distance, is an important factor while designing the HVAC system. It is best practice to provide toilet exhaust, kitchen exhaust, DG and boiler exhaust at the highest level since fresh air intake for most of the public area AHUs and for TFA AHUs are located at the podium level or at the typical floor level. This completely eliminates the possibility of short-cycling of fresh air and exhaust air.

The type of filtration for the fresh air is also important in terms of surroundings. We may have to use any type from the simple HDP filters to microvee filters and sometimes even carbon filters, depending on the quality of surrounding air.

Fire Safety

Fire safety becomes the most crucial part of the preoperating drill for a hotel. The local Chief Fire Officer has to confirm that the various fire safety measures have been provided as per the codes before he issues an occupancy certificate. Hotel operators have a parallel and a greater role before the hotel can be ready for softcommissioning.

The most important steps to be considered for fire safety, while designing the HVAC system for a hotel are:

- Thickness of G.I. sheets to be maintained as per IS or SMACNA Standards.
- Property of insulation materials (to be fire retardant).
- Fire zoning to be maintained with zonal walls upto full floor height.
- Fire doors with 30-minutes rating at all AHU rooms and fan rooms.
- Motorized smoke dampers at the supply air and either motorized smoke damper or fire damper with fusible link at the return air crossing of AHU room walls.
- Smoke exhaust system for typical floors, banquet halls, convention centre and all other high occupancy areas.
- Pressurization system for fire-escape staircases and for lift wells.

Pollution Control

The State Government Pollution Control Authorities and Municipal Pollution Control Departments play an important role while issuing a Commencement Certificate (CC) before the start of construction of the building, as well as while issuing an occupancy certificate for operating the hotel.

The following factors need to be kept in mind while designing:

- Selection of ozone friendly refrigerant.
- Kitchen exhaust to be scrubbed before it is let out to the atmosphere.
- Odour control through carbon filters, ESPs or ozone generators.
- Indoor air quality, generally as per ASHRAE norms.
- Quality of cooling tower make-up water
- Adequate supply and exhaust air changes in basement, car parking, toilet exhaust, kitchen, laundry and sewage treatment plant.
- Noise control on equipment such as chilling units, DG, cooling towers, ventilation fans.

Space Planning for Plant & Equipment

The type of usable spaces in the hotel industry has drastically changed over the years and hence the most optimum solution is required to minimize the plant and equipment floor spaces while designing the HVAC system. Some of the solutions for proactive designing are:

- Location of plant room in the lowest basement as extended areas of other plant rooms such as electric substation, LT panel rooms, boilers, water tanks, water treatment plant, fire pump room and engineering offices.
- Usage of double heights available in basement and other back-of-house areas to locate fans, AHUs and electrical panel by creating accessible lofts.
- Usage of common shafts for all services.
- Usage of service floors for AHUs and fans, besides being used as transfer floors for services.
- Location of cooling towers on the podium terrace to reduce pipe length and pumping energy.
- Usage of additional height on the last typical floor to install ducting and piping and other services so as to provide usable space on the terrace.