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Cooling the Taj Group of Hotels

Design philosophy developed over years of experience helps improve equipment and system performance today.

Lobby of The Taj Mahal Palace Hotel, Mumbai.
Photo courtesy of The Indian Hotels Company Ltd.

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K.D. Deodhar is a mechanical engineer from Shivaji University, Kolhapur and joined the Taj Mahal Hotel in Mumbai as an assistant engineer under Y. P. Pundol in 1970. With 35 years experience in the Taj Group, he is instrumental in planning, designing and execution of all engineering services including HVAC, plumbing, electrical and fire fighting. In the field of automation he has implemented technology upgradation and energy management. He has also initiated several environmental issues such as water recycling, water conservation, energy saving, solid waste reduction and biogas generation.

The Taj Mahal Palace Hotel in Mumbai is the oldest, single-owner-over-the-years hotel in India, originally constructed in 1903. Over the 103 years that the hotel has been in existence, a central air conditioning system has been used for almost 60 plus years. Over these long years the engineering management of the hotel has developed its own time-

tested maintenance schedules, equipment standards and design philosophy which is widely applied today in its 50-hotel chain all over India and 12 hotels outside the country.

The engineers at the hotel have learnt to meet a wide variety of demands imposed on the air conditioning systems, 24×7, summer or winter, by its guests from all over the country and different parts of the world. Whether they are sleeping in the bedrooms, eating in the restaurants, drinking in the bar, attending a conference or wedding reception in the banquet hall or partying at the night club, the air around them must be crisp and fresh, odorless, without any obtrusive noise. At the same time, the hotel's senior management expects the running costs comprising energy bills and water bills to be within reasonable limits.

Chiller Packages

There is a preference for screw chillers upto 300 ton capacity and centrifugal chillers 350 ton and above. Modular capacities help to achieve flexibility in operation depending on the internal load and the season. Thus, the Taj Mahal in Mumbai with 585 rooms in both the old and new wings combined has seven chillers totaling 2700 tons (2 × 600 ton plus 5 × 300 ton).

A minimum capacity standby unit takes care of any outage due to maintenance or breakdown. At least two screw chillers are factory fitted with desuperheaters for the hot water requirements of the hotel.

Since the HVAC system consumes 38% to 42% of the electrical energy of the hotel, and chillers are the major power guzzlers, they are selected with the lowest kW per ton in the region of 0.56 – 0.58.

All chillers used are water-cooled and since municipal water supply is expensive and can be in short supply during times when the monsoon rains are below normal, water treated from a sewage treatment plant (STP) is the answer.

Treated water from the STP is then fed to the cooling tower and the condenser water cooling circuit. To protect the condenser from any adverse effects of water from the STP, 90:10 cupronickel tubes and 20% extra tube surface are always specified and supplied by the chiller manufacturer.

Chilled Water Distribution Systems

A well-designed water distribution system using both primary and secondary circuits with variable speed drive on all secondary pumps is essential to maintain comfortable

temperature conditions in all areas and conserve energy.

All the loads comprising air handling units and fan coil units are provided with temperature controls and modulating valves to obtain the required cooling without unnecessary flow of chilled water. Hence to obtain full advantage of an efficient water distribution system, the control system must be fully supportive.

AHUs and FCUs

All air handling units are doubleskin construction to international design standards with reputable centrifugal fans mounted on vibration isolators and well designed condensate drain arrangements. Noise level is not to exceed 45 dbs. Cooling coils for lobby and large public areas where the fresh air requirement is high are all 6 row deep.

Fan coil unit noise level is not to exceed 40 dbs and condensate trays installed are stainless steel.

Both the AHUs and FCUs are fitted with flow control valves and temperature controllers.

Air Distribution System

As a good practice to follow, ducted return air systems are now standard. This practice not only helps to reduce the cooling load on the air handling unit but also avoids mixing of return air with other air, dust and moisture through openings in partitions above false ceilings. Both supply and return air ducts are insulated to reduce heat pick up from the surrounding air.



While in new installations, installing return air ducts is fairly simple, the same cannot be said about existing old installations and on such projects "ducted return air" is adopted whenever renovation of false ceilings is carried out. No doubt the initial cost of additional sheet metal return air ductwork with insulation does increase but this increase can be justified by the saving in running costs of the chiller.

Supply air grilles are carefully checked for size to avoid noise due to high velocity and return air duct area is twice the cross sectional area of the supply air duct.

Noise Levels

Most guests are now more aware of objectionable noise levels in bed rooms as well as public areas and insist on silent performance. Proper selection of the right make and model of FCU and AHU and a well installed system with vibration isolators and flexible canvass connections are both essential.

Providing the Right Indoor Air Quality

All guest rooms and public areas are fed with cool, dehumidified fresh air, which is passed through treated fresh air (TFA) AHUs with 8-row deep cooling coil, reheat coil and high quality air filters.

Guest rooms receive 50 cfm fresh air each while the corridors outside such rooms receive 0.5 cfm per square foot floor area. Toilets attached to guest rooms are exhausted at the rate of 60 cfm per toilet, thus maintaining a slight negative pressure in each guest room.

Fresh air intakes are so located as to avoid bringing in kitchen exhaust, toilet exhaust and humid air around cooling towers. Hotel lobbies are pressurized to avoid dust entering through the entrance door, which during wedding receptions and large conferences tend to remain open for long periods.

Care is taken to ensure that condensate drain pans below AHUs and FCUs are kept dry to prevent breeding of microbes and consequent generation of odors.

Ozonisers are installed in all bars where smoking is permitted as well as in restaurants with open kitchens to eliminate cooking odors and at the same time fresh air quantities are maintained at recommended levels for proper health.

With a 7000 km coastline and many of the group's hotels located in coastal cities such as Mumbai, Goa, Kochi, Chennai and Kolkata, high ambient humidity is a source of concern. Also whenever a guest opens a window he allows humid air to gush in and condense on the chilled walls and grilles inside the room, which quite often are below the ambient air dew-point level. This condensate encourages fungus growth and discoloration of the walls besides causing unpleasant odors and in some cases allergy attacks on unsuspecting guests. All windows are therefore locked and can only be key operated by authorized hotel personnel.

Controls for AC Systems

A modern Building Automation System (BMS) is installed in every hotel simplifying the work of the maintenance staff. The fan coil units in guest rooms are operated by a stand-alone key switch and temperature control is by means of a dual temperature setting thermostat. One setting is for the guest at $22^{\circ}\text{C} \pm 1^{\circ}\text{C}$ while the second setting at 24°C maintains the room at a slightly higher temperature when the room is unoccupied.

All equipment including pumps, AHUs and cooling towers are connected to the automation system. The BAS helps not only to operate the AHUs but also to automatically maintain the proper temperature, humidity, air flow, cooling tower, water temperature and pressures. Such control systems have improved the operational standards, offered flexibility and promptness in operation, resulting in energy savings.

Kitchen Ventilation

The kitchen areas are ventilated with 45–50 air changes per hour and exhaust systems are installed to maintain these area at a slight negative pressure, thus preventing kitchen odors from polluting the dining areas, banquet halls and the lobby.

The room service, vegetable preparation, fish and meat preparation, pastry and confectionery making areas in the kitchen are air conditioned using fan coil units with chilled water circulation.

Cold Storage Rooms

These have been modified over the years as technology has improved and today all hotels install prefabricated, polyurethane-foaminsulated coolers and freezers with stainless steel outer as well as inner skins. The standard floor panel inner skin is replaced with natural stone (Kota) which is easier to maintain and clean.

All refrigeration equipment is of a reputable make and condensing units used are water-cooled with semi-hermetic compressors.

Free Cooling

In cold areas where the ambient temperature drops after the hot summer months, to around 15°C to 18°C , air distribution ductwork and suitable dampers are designed and installed to use outdoor air directly for cooling the internal areas thus saving considerable energy.

Standard Manuals for Chief Engineers

To ensure compliance with our engineering standards developed over the years, standard guidelines and manuals have been prepared for all chief engineers that they must refer to and follow in case of doubt. A central purchase office coordinates all purchase requests with the chief engineer of the hotel concerned to ensure that the item purchased meets the standards laid down in the manual.

Summary of Energy Conservation Measures

Since the air conditioning system in a hotel consumes 38% to 42% of the hotel's electrical energy, conservation measures are essential for economic operation. The following conservation initiatives can be implemented in the design of the hotel's air conditioning system and installation:

- Use of modern chiller packages with low I kW / ton. Screw chillers with 0.58 to 0.60 I kW / ton and centrifugal chillers with 0.60 to 0.70 I kW / ton are available under our operating conditions from most manufacturers.
- Desuperheaters should be included in the chiller design for generating hot water for the hotel.
- Variable frequency drives should be used for cooling tower fans, secondary chilled water pumps, ventilation fans and air handling units.
- Room thermostats for guest rooms should have dual temperature setting facility.
- Modulating chilled water valves on all air handling units.
- Well planned chilled water distribution with primary and secondary circuits to feed all areas of the hotel and generate cooling effect.
- Pumps for primary and secondary chilled water systems should be of high efficiency.
- A BAS system is essential.
- Careful selection of condenser water pumps with accurate design of static head to save energy. Variable speed drives in cold climates save even more energy.
- Provide a thermostatic control to sense cooling tower basin water temperature to reduce cooling tower fan speed thus saving power.
- Install an offline sand filtration unit on the cooling tower sump with a 1/2 – 1 hp pump to continuously circulate condenser water through the filter and provide two complete water changes per day. This simple addition will minimize scale formation on condenser tubes of the chiller package and save power.

