Hotels & Air Conditioning: Some Aspects

By S. K. Murthy
Eskayem Consultants Pvt. Ltd.,
Mumbai

Introduction

Mumbai, the commercial capital of India with a large population of over 12 million, is in need of hotel rooms to meet the growing business and tourist traffic. Currently Mumbai has over half a dozen new hotels in the 5-star and 4-star category, either in the construction or planning stage. This article should be of interest to new owners, consultants and contractors involved in the HVAC systems of hotels.

Excepting in the case of low budget suburban and rural hotels, all the other hotels provide air conditioning facilities in the guest rooms and most of the public spaces, as a matter of course. There are several types of hotels which have typical characteristics. *Table 1* shows some of the features of the better quality product.

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Some Aspects of Design

In low budget hotels, 3-star and lower, window and split units for the guest rooms is a general norm with packaged units for the restaurant and public spaces wherever required. For hotels of say 70 rooms and over, it is generally a centralised system with chilled water produced at a central space and distributed to the various rooms and spaces for cooling through appropriate air handling and fan coil units. These central air-conditioning plants present considerable scope for design and innovation. Some of the aspects are discussed here.

Table 1: Design features of starred hotels

Type	Average persons per room	Features
Luxury 5-star	1.2 to 1.3	Large rooms and public areas, multiple restaurants, function areas.
Convention Hotels	1.5 to 1.7	Large number of rooms, large lobbies, convention halls and meeting rooms, multiple restaurants.
Resorts	1.8 to 2.4	Spacious public spaces, clustered rooms with or without kitchenettes and leisure facilities.
3-star Hotels	1.5 to 1.8	Limited public areas, smaller rooms with adequate decor, one or two multi-cuisine restaurants.

About the Author

S. K. Murthy is a graduate engineer from Andhra University and has 60 years experience in the HVAC field of which 55 years has been as a consultant. He was the president of ISHRAE Mumbai Chaper in 1997-98.

Guest Rooms

A hotel means guest rooms. All other areas are there to support a comfortable say for the guest. Nearly 60% of the air conditioning goes to guest rooms. The air conditioning needs to provide:

- Comfortable room temperature and humidity.
- Personalised control over the room environment.
- Adequate ventilation for good air quality in the room and also the toilet.
- Equipment of low noise level
- Easy maintenance.

Comfortable room temperature rules between 20 deg. C to 24 deg. C DB and a humidity of anywhere between 50 to 65% RH. Typically a guest room has large external window which by and large, influences the room load. The guest room profile in *Figure 1* displays the overwhelming influence of the east and west facing rooms. Chopping of the prominent peaks could bring about healthy savings in the cooling load.

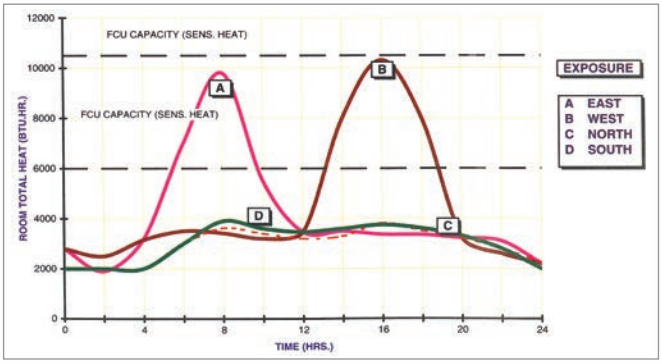

Figure 1: Load profile – single guest room (single glazing)

Human comfort is not a mere metabolic heat-balance. Even in an otherwise perfectly balanced environment, some subjects were found complaining and restless because there is no room thermostat to control and monitor their environment. It is for this reason that a personalised room control thermostat is an indispensable though psychological element of comfort.

Ventilation to the guest rooms is a much debated design parameter. The minimum requirement is 15 cfm per person to maintain minimum indoor CO concentration and odour perceptions of 80% of visitors. This does not take into account the emission of radon and formaldehyde from building construction materials. This also does not consider the pollution level of the outside air. These two items are imponderable. With a profitable occupancy of two persons per room, a ventilation rate of not less than 40 cfm seems to meet the need. The toilet ventilation by way of exhaust needs 6 to 8 air changes, being a private toilet, and that would be anywhere from 40 cfm to 60 cfm. Ventilation air for the room varies therefore from 40 to 60 cfm. In addition, the guest room corridor is also supplied with pre-conditioned outside air, to simplify ducting and distribution.

Figure 2 shows the load profile for a 550 room property. The contribution from the ventilation air is enormous and this could be reduced by 60-80% by an appropriate air-to-air heat recovery between the toilet exhaust and outside air. Saving could also be achieved by employing recirculation of the corridor air as well.

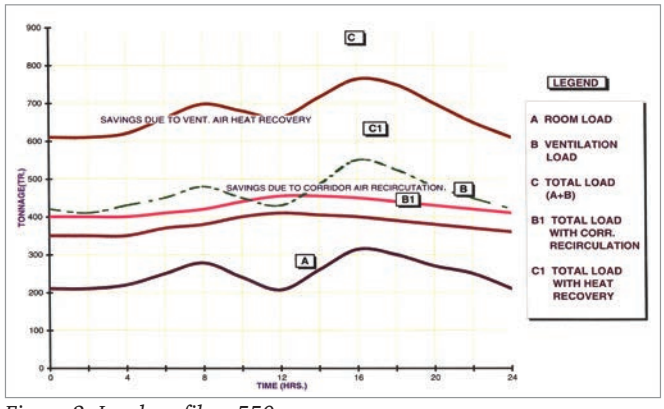

Figure 2: Load profile – 550 rooms

The fan coil unit is a universal selection for a guest room. Units need to be selected for achieving a design goal of NC 30-35 in the room.

Public Areas

Public areas can be divided as shown in *Table 2*.

Table 2: Types of public areas

24-hour spaces	Lobbies, front office, coffee shop
Food outlets	Restaurants
Function spaces	Banquets, ball rooms, meeting rooms
Back of the house	Administration, kitchens, laundry, store, etc.

24-hour Spaces

Lobbies are characterised by varying occupancy and outside air ingress. It is always desirable to have an airlock or a revolving door to minimize uncontrolled outside air entry. Variation of the ventilation air according to the occupancy could result in substantial energy savings. This could be through modulation of the ventilation air damper through an IAQ sensor or a small packaged heat recovery device. Such steps pay back in 8 to 15 thousand operating hours, which means 12-20 months period in a 24-hour operating hours regime. 24-hour coffee shops are similar to a lobby without the problems of outside air ingress. Typical load profile is in *Figure 3*.

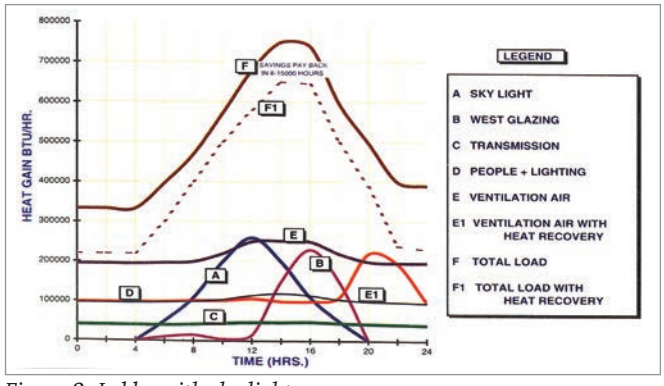

Figure 3: Lobby with sky light

Food Outlets

Food outlets have typically high lighting loads, food odour (particularly Asian cuisines), display kitchens and varying occupancy. Odour control and a display kitchen demand large amount of ventilation air, even when make-up kitchen hoods are used.

Recirculation systems have been found to be wanting in exercising a desired odour control even with ventilation rates of over 25-30 cfm per person. 100% outside air circulation with a supply and return fan and an air-to-air heat recovery system would present a viable and economic alternative. In Russia, such a system is mandatory. *Figure 4* shows load profiles for recirculation and once-through air conditioning systems for a typical restaurant.

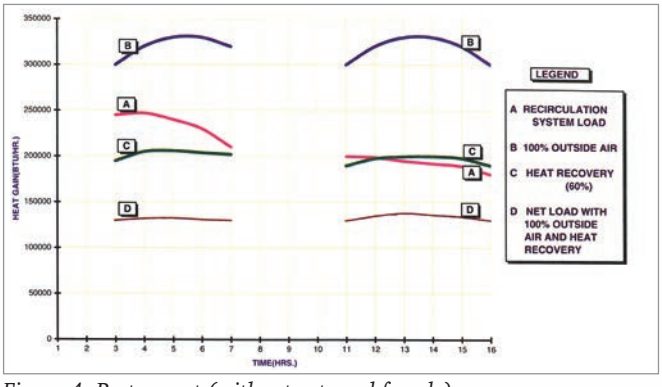

Figure 4: Restaurant (without external façade)

The bar is another area where the occupancy is highly varying and where tobacco smoke control is a demanding design need. A once-through system is an ideal solution. The major problem in adopting such systems is the larger air handling unit space to accommodate a return fan and a heat exchanger and openings for outside air intake and exhaust.

Function Spaces

Heavy and varying occupancy, very high lighting loads and relative humidity control are the design characteristics to reckon in banquet halls, ball rooms, board rooms and meeting rooms. Because of short time occupancy, the ventilation air could be 15 cfm per person to control body odours but it is desirable to have lower space dry bulb temperature of say 70-72F to offset higher mean radiant temperature due to dense occupancy and also to reduce latent load.

A system of variable speed drive could be a standard design to cope with varying occupancy. In such a system, an IAQ sensor should monitor and control the ventilation air quantity.

Health Clubs are very low occupancy areas where a variable volume system will optimize the plant utilisation. Where a gymnasium forms part of the club, it is preferable to have a separate air handling unit.

Back of the House

These areas are administration, kitchen and laundry. More and more hotels are going in for air conditioning of kitchens and laundries. An ideal system would have been 100% outside air with heat recovery but problems are faced in heat recovery equipment because of grease in the kitchen and lint in the laundry.

- Independent supply and exhaust systems for the kitchen hoods.
- A re-circulating system for the remaining kitchen with 10 to 12% ventilation air.
- The kitchen in the net will remain under negative pressure.

The load density is in the region of 80-100 BTU per sq.ft. while maintaining a space temperature of 27-29 deg. C DB.

Likewise in a laundry, the exhaust air from the tumbler dryer and flat work ironer could have independent supply and exhaust system while a recirculation system similar to a kitchen will maintain a space temperature 27 ± 1 deg. C . The load density in a laundry is more on account of hot body radiation and steps to minimise such radiation will greatly improve the comfort level. Another contribution comes from leaking steam traps and poor insulation and cladding of the steam and condensate pipes.

Refrigeration Equipment

Electricity is one of the major expenses in a hotel and the specific consumption varies from 50 to 100 kWh per available room. It depends on the location, building envelop, class of service, efficiency of the plant and machinery and of course the energy management. A median figure is about 60-65 kWh. At the current average rate of Rs. 4.5/kWh the electricity charges range from 3% to 15% of the room rental (see *Figure 5*).

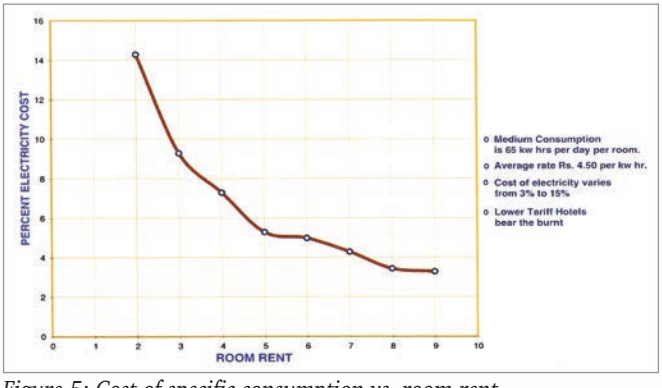

Figure 5: Cost of specific consumption vs. room rent

Of the specific consumption, as much as 45-50% is consumed in the air conditioning and allied plant. Out of this, 40 to 50% goes towards the refrigeration plant while the remainder is contributed by pumps, cooling towers, air handling unit, etc. It is for this reason that selection of the main refrigeration plant assumes importance what with the variety of plant now available in the country.

Table 3 shows the variety of equipment available in the market to make up a central plant and the IKW/TR indicates these are some of the figures thrown about in the market. With shortage of electricity and ever increasing tariffs, vapour absorption systems gained ground. These systems also merited 100% depreciation as they are listed as energy saving equipment. With changes in the rules of administered price mechanism for hydrocarbons, it has become necessary to assess the plant selections almost every year. *Figure 5* exhibits the per unit energy costs vs. cost

per TR hr. It is easy to establish the breakeven of various systems from *Figure 6*.

Table 3: IKW/TR of central plant equipment

Vapour Compression Systems	Range	Median
• Reciprocating chillers	0.75 to 0.85	0.81
• Screw chillers	0.67 to 0.75	0.70
• Centrifugal chillers	0.60 to 0.68	0.65

Vapour Absorption Systems	Range	Median
• Steam fired	4.5kg of steam per TR hr	0.35 lit LDO
• Direct fired	–	0.35 lit LDO
• Natural Gas fired	–	0.30 Nm^3

Almost every hotel has 100% captive generators, which rust on their foundations since they are called upon to run not even 300 hours in a year Most of the engines are 2-stroke high speed (1500 rpm) turbocharged and after-cooled units, which are cheaper. Slower speed engines using cruder oils will be slightly more expensive but the cost of generation (fuel cost) is much more economical; most of the State Electricity Boards and Public Utilities are eager to allow captive generators to be put to beneficial use.

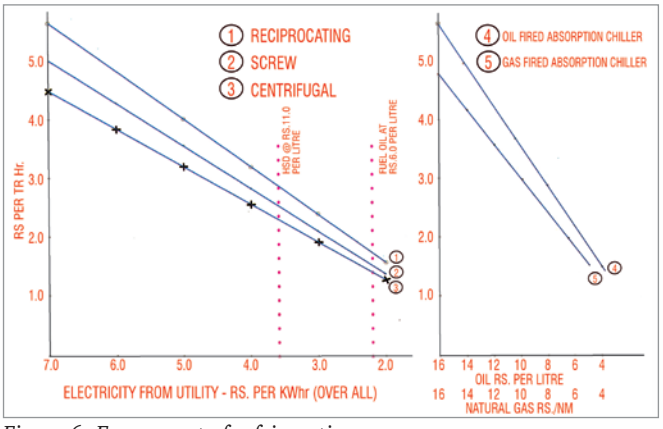

Figure 6: Energy cost of refrigeration

This gives the hotelier considerable advantage

- In keeping the generating sets in good working order.
- To produce power at much lower cost than the utility and substantially reduce the power bill.

Advent of natural gas in Mumbai and Delhi has added a new dimension to the equipment selections. When the availability of natural gas and its price get stabilized, natural gas could be a prime fuel for not only air-conditioning but also heating loads, kitchens and laundry equipment.