



Air Conditioning of Restaurants

A fine dining restaurant at dinner time

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Introduction

Eating out is gaining popularity due to the rising disposable income in the hands of the average Indian family. The variety of cuisines available, the large price range and the wide choice of restaurants in our cities give most families an opportunity to eat out at least once every week or two. The choice of restaurants ranges from tiffin centres in South India with limited or no seating, fast food outlets for pizzas and burgers, *Udipi* restaurants catering to a fast moving clientele with *idlis*, *dosas*, etc. at one end, to the more expensive specialty restaurants serving Chinese, Thai, Mexican or *tandoori* delicacies and fine dining restaurants for gourmet eating at the other end. In the middle of the spectrum are food courts commonly seen in shopping malls that serve a variety of food under one roof.

These eating places differ from one

another not only in the functions they perform, but also in their décor, seating, cooking practices and service. The cost of the décor can vary from Rs. 500 to over Rs. 10,000 a sq. ft. Air conditioning can also be as varied. High wall split room air conditioners are used at the low end, but at the high end one expects:

- Close control of temperature and RH
- Control on air movement (drafts)
- Odour control
- Energy efficiency

Meeting these requirements while air conditioning a restaurant can be challenging, and the approach has to be tailored to suit the application. In this article we will describe the approaches for the following types of restaurants:

1. Fine dining restaurants
2. Coffee shops
3. Food malls

Fine Dining Restaurants

These are the top end restaurants where one expects not only very good food and service like in a five-star hotel, but also unobtrusive air conditioning and total comfort. The air conditioning must not be noticed, only felt. When one pays fancy prices for food, one does not expect to smell kitchen odours, hear the

About the Author

M. H. Lulla is an electrical engineer from Annamalai University. He worked with Blue Star Limited for seven years before starting practice in 1973 as an air conditioning consultant, and has been working on diverse projects ranging from 5 TR to over 8000 TR, in applications varying from comfort cooling to process cooling to clean rooms. He has engineered close to 200 clean rooms, 200 auditoriums and several other projects. He has air conditioned the Green Building for Turbo Engineering which received over 62 credits to become one of the three top rated buildings in the World.

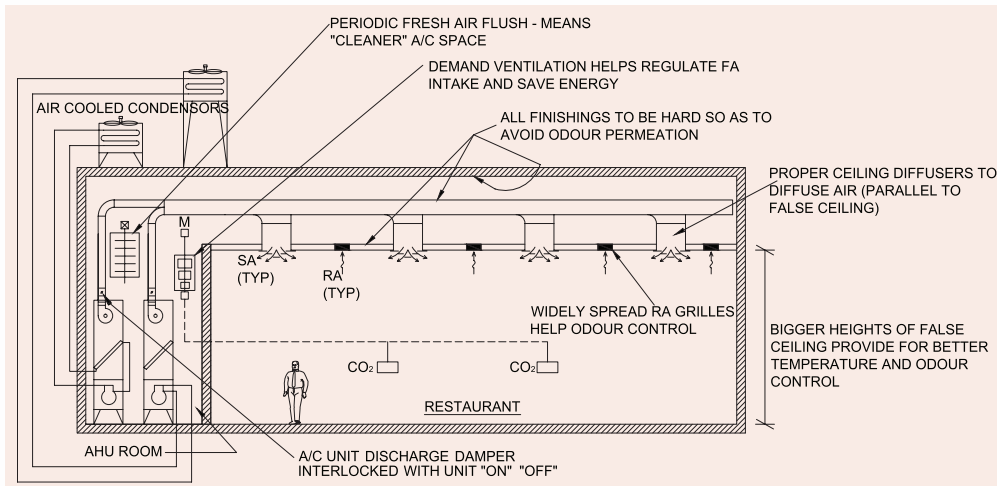


Figure 1: Sectional detail of a restaurant air conditioning system

air conditioning noise or feel the vibrations. There are smoking and no smoking areas. Air conditioning design needs to take care of all these factors. All very easy to say, but not as easy to design and execute!

A Case Study

A newly opened fine dining restaurant in Chennai had the following parameters:

- Air conditioned eating space of 3,000 sq. ft.
- Area for live cooking inside the air conditioned space (a central island type kitchen hood of size 9' x 4'; cooking would be predominantly on gas burners).
- Apart from the above, there were the non customer interface areas like stores, main kitchen, preparation area, washing area, etc. amounting to another 3,000 sq. ft.

Diners could order what they wanted and see it being cooked. They could ask to see raw, fresh food before it was cooked. For instance, one could ask see the fish before placing the order, and it would be shown in the cold room spread out on ice cubes in a tray.

Design Summary

The exhaust hood over the cooking area would need 7,200 cfm of exhaust air (200 fpm for every sq. ft. of mouth area). The eating area would need at least 2 air changes per hour of fresh air (FA), i.e. $3,000 \times 12 \times 1/60 = 600$ cfm. These two factors put together would

The Role of Professional Education

Eating out owes its popularity partly to an important factor, namely the growth in the number of restaurants – supply creates demand. Most of the newer restaurants owe their roots to professionals turned out by the ever-increasing catering institutes which attract a steady stream of students, particularly from self employed families. On passing out, these students with their entrepreneurial background and the newly acquired domain knowledge of catering have been introducing innovative features in their ventures like take away counters, self service, etc. They have also fuelled the growth of franchises like KFC, McDonalds, Dominos and Pizza Hut.

mean total FA of 7,800 cfm. This was the single largest heat load factor, working out to 35 TR of cooling. (Chennai has a design wet bulb of 28°C.) The rest of the cooling load was just 20 TR.

System Layout

A central DX system comprising 3x 18TR condensing units on the roof top (above the 4th floor) connected to a 54 TR AHU on the ground level with a three circuit cooling coil was designed. Ducting was spread all over the seating area from the AHU room, and ceiling diffusers were used to avoid

draft. The ducting was covered with a false ceiling and the void over it served as the RA plenum. The AHU had a small bypass section to allow for about 25% air bypass on winter nights.

The AHU motor was on a variable speed drive (VSD), which would help regulation of the fan speed in synch with the exhaust air quantity of the cooking range hood.

The hood exhaust of 7,200 cfm was effected by a kitchen exhaust fan, a direct drive plug fan working on 50mm static. The fan speed was variable to suit the load on the cooking table. (It would have been more appropriate to bifurcate the hood into two halves, each with its independent fan, and operate the fans to suit the cooking load.)

System Operation

The restaurant was very popular in the beginning – the turnover per chair per food session clocked 2 and above. The average hourly energy cost of airconditioning was:

$$54 \times 5/- \times 1.5 \times 0.5 \cong \text{Rs. } 200 \text{ per hour.}$$

Assuming that the place could seat 60 people and each diner was in his chair for 2 hours, the cost of air conditioning per diner was $200 \times 2 / 60 \cong \text{Rs. } 7$.

The live cooking was dispensed with about 3 years after start up – the cooking hoods were separated from the eating space with a glass partition. The air conditioning was cut down to 20 TR, retaining the same ducts. This resulted in the operating cost being brought down from Rs. 7 to Rs. 2 per diner.

The glass separating the conditioned space from the hoods would tend to fog in places like Chennai. This was overcome by reducing the load on the cooking area – from a live cooking space it became virtually a show kitchen, where precooked or half cooked food was grilled and tossed up. Such show kitchens can have small 3 TR fan coil units to reduce condensation risk and keep the chef comfortable.

Smoking and No Smoking Sections

Some fine dining restaurants have a separate section for smokers. Ideally, these areas need to be separated, both physically by a partition and mechanically by a separate air conditioning

system, with additional use of efficient air filters and exhaust fans to further enhance the separation.

In case these areas are not so separated, a separate exhaust duct designed for about five air changes per hour needs to be installed, with exhaust grilles no higher than 7'-6" directly over each table. The exhaust air quantity is best compensated by a treated fresh air system pumping back the same five exhaust air changes but at a point which separates the smoking from the no smoking areas.

Private Dining Rooms

Fine dining has a newer variant – private dining. Private Dining Rooms (PDRs) were first introduced a few years back. Since then, the demand for them has been growing. A number of hotels are now providing separate PDRs. Hotels in China are known to have converted full guest room floors to PDRs. This practice is fast catching up in India. Even smaller cities like Tiruchirapalli have shown an appetite for PDRs. Newer hotels are planning close to a dozen PDRs each.

A PDR for about 12 to 15 people charges anything from Rs. 1 lakh to 5 lakhs for a meal. It has an attached toilet, a small alcove for a show kitchen, a small bar counter, a good projection system and a large sized screen. The seating arrangement includes a small informal area with sofa sets, in addition to the dining table.

In other words, a PDR becomes a bar, recreation, rest and eating space all rolled into one. A good air conditioning system will need to effectively control odour in addition to the usual control of temperature and RH. It will be necessary to exercise this control without adding to ambient noise, vibration and drafts.

The good old silent, multiple fan coil units (FCUs) are a suitable choice. They can be installed in large plenum spaces over areas like the kitchen and the toilet. Cooling coils on these FCUs will need to be at least 6 rows deep to handle the high latent load of a large amount of fresh air. Some form of RH control is a must to meet part load requirements adequately.

Most of the show kitchens in a PDR can be equipped with a large sized domestic chimney available in the market. The outlet of this chimney can be connected to a good electrostatic precipitator (ESP) which discharges the cleaned air into the RA plenum of the air conditioning system. (The exhaust fan is on all the time, and the toss up operation or a small stir fry takes just a few minutes. Therefore in a show kitchen, the temperature of the exhaust rarely exceeds the outside dry bulb temperature, and does not add significant load when mixed with the return air.) The toilet can have a continuous exhaust which would help bring in FA to the FCU and achieve the desired odour control.

PDRs may have the facility for good quality picture projection, due to which they are popular with cricket fans who are known to book a PDR for a full day to closely watch a one day match. Since such events can become noisy, each PDR needs to have its own independent air conditioning so that noise does not permeate from one PDR to another through the air conditioning system.

Coffee Shops

All five-star hotels are obliged to have a restaurant that is

open 24 hours a day. Due to its 24 hours usage, it has large load variation. Generally the coffee shop plays this role.

Coffee shops often open out into the main hotel lobby. Sometimes they are not fully segregated from the lobby. Due to this locational feature, odour control is of extreme importance. The supply air (SA) and return air (RA) grille locations need to be designed for effective



Figure 2: Live counter during breakfast in a coffee shop

The Coffee Shop – All in the Space of a Day

A successful coffee shop calls for careful planning. Its business manager has a game plan for keeping the coffee shop full twenty four hours a day.

- The early hours of the day – midnight to 2 am – are for the movie buffs. People coming out from the last show are pulled in through complimentary coupons given in the movie hall.
- The next two hours – 2 to 4 am – are targeted at news reporters and staffers who work on late night presentations in newspaper offices.
- The next two hours go towards preparing for breakfast time.
- 6 to 10 am is breakfast time. Most star hotels offer complimentary breakfast in their tariff plans. Guests catching early morning flights start early.
- By 10 am the breakfast is done, and snacks and coffee pull casual visitors from the shopping arcade.
- Coffee shops do not see themselves as a competition to the fine dining restaurants in the same hotel for lunch and dinner, since they offer a different value proposition to their patrons. They spread out a lavish buffet, and diners in need of a quick but good meal (without the waiting time that other restaurants entail) patronize them.
- By three in the afternoon it is snack time. The nearby movie halls bring in good traffic to a coffee shop.
- By 6 pm it is time for the board room conference and meeting crowds to catch a bite on the way back home.
- Dinner stretches from 8 pm till midnight and more. Spirits flow high during this time.
- By now the small hand of the clock has finished two full circles, ending a typical day and beginning a new one at the coffee shop.

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odour control so that coffee shop smells do not waft into the lobby. SA grilles are best sited closest to the entrance of the coffee shop, and RA grilles farthest from the entrance.

A coffee shop starts the day by serving complimentary breakfast to hotel guests. A buffet breakfast in a large hotel can have as many as 200 items for a thousand guests, or as little as 20 items for less than sixty guests. Most food items offered in a buffet are kept invitingly open for display. This means that the air around the buffet counters has to be as clean as possible. Micro-vee filters in the system are desirable, as also some humidification. This would minimize the dehydration of cut fruits and salads, if sensible heat from induction cookers is high. Ideally, the food display area of a large coffee shop should be a notional zone for the purpose of air conditioning, and should have an independent system. The food area will need lower pressure, higher humidity and cleaner air than the rest of the coffee shop. Specific eating areas may have separate air handling systems, fitted with fresh air fans powered by VSD motors whose speed can be varied to suit occupancy levels (demand ventilation). Where the seating capacity exceeds 150 – 200, multiple notional zones are recommended with independent AHUs for operational and functional control. This would lead to greater energy efficiency.

Food Courts

Shopping malls are a multipurpose family destination for a couple of weekends every month. Most malls have good food courts, and owe their popularity in no small measure to them. A conventional food court consists of multiple food outlets fronting on to a common eating area which provides eating space seated or standing, and for moving around and buying food from any of the food outlets.

Each food outlet generally needs:

1. Storage space, freezers, coolers and ovens. The food outlet is

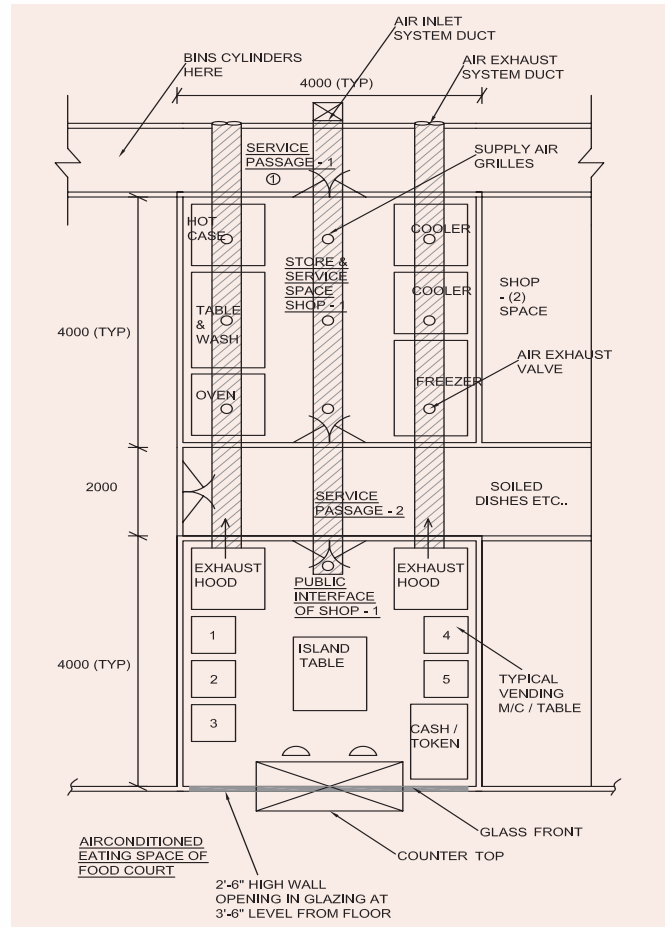


Figure 3: Schematic plan of a typical Food Court outlet

generally stocked up with pre-cooked or partly cooked food from the central kitchen of the outlet.

2. Wash area for pots and pans and sometimes for dishes and cutlery (where disposable items are not used).

3. Toss up kitchen and cooking space where final touches are given before the food is served.

4. Plate set up space where plates are made up.

5. Cash and token table where the first customer interface takes place.

6. Space to store gas cylinders, bins for disposal, drinking water, etc. Figure 3 shows the typical layout of a food outlet.

Figure 4 is a typical food court, showing a food outlet and eating space.

Air Conditioning of the Eating Space

The air conditioning system is designed as for a normal eating space but with extra fresh air which is expected to leak into the food outlets. This may be estimated at 3 to 5 air changes of the shop space per hour.

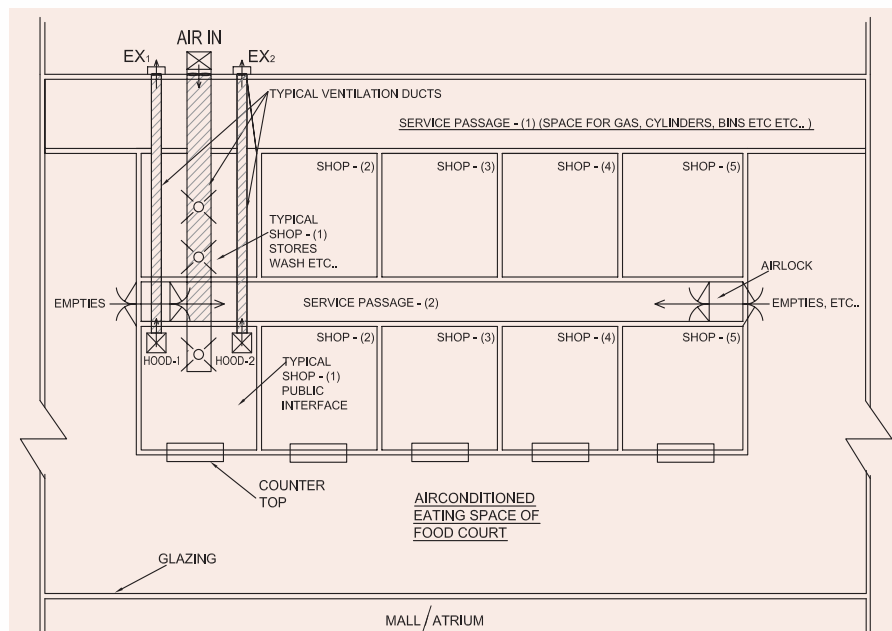


Figure 4: Key plan of a Food Court

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Food Outlet Cooling

Each outlet has an independent air inlet and exhaust system designed as a normal kitchen – say, 40 air changes of exhaust and 38 air changes of inlet air. The slight negative pressure draws cold air from the eating space and provides an element of thermal comfort to the counter staff.

The service area of each outlet would also need a ventilation system. This can be designed based on the heat load, taking into account any other design features. As a general rule, this area can also be designed like the kitchen with 40 air changes per hour of exhaust and 38 air changes per hour of inlet air.

Design parameters for the outlet and the service area being the same, one can have a common system for the two spaces as shown *Figure 3*. Since this system is independent of the central air conditioning, it is run from the electricity provided to each food outlet and paid for by the meter.

Conclusion

Restaurant air conditioning design is characterized by one important design feature – adequate fresh air. *ASHRAE Standard 62* lays down the recommended cfm/ person. This is at best a guideline. In practice, these values need to be used carefully as they do not necessarily ensure full odour control. Apart from this, if the restaurant has a live counter, its exhaust has to be compensated by increasing FA to the AHU.

The large FA intake tends to skew the heat load towards latent

load – the sensible heat factor (SHF) can be as low as 0.7 and the cfm/ TR can be as low as 300. Despite such low cfm/ TR, it is generally difficult to supply this air quantity in the conditioned space without creating drafts, because it is close to 3 cfm/ sq. ft. To avoid drafts, air distribution is best done with ceiling diffusers. This is especially necessary in fine dining areas, where a diner is seated for a longer spell of time than in a fast food area or a coffee shop.

For small establishments (less than 100 sq. m.), it is adequate to use package units or ductable splits preferably with deeper coils – minimum 4 rows deep. When the restaurant is a part of a hotel or an office building that has a central chilled water system, an independent AHU with a deep cooling coil is an effective solution.

When using package units or splits, the full load must be met by two or more units. This combination is able to follow the cooling load curve with greater fidelity. With multiple units, in case of breakdown of one unit, the remaining units would provide some degree of comfort.

Since standby equipment is generally not provided, vendor selection should factor in service response time. For larger restaurants it is advisable to have multiple zones, since individual AHUs can handle zonal requirements better. These multiple AHUs are connected to a chiller system supplying water at about 5°C (about a degree or two lower than normal). Generally, restaurant loads tend to be more latent than other comfort spaces; colder water inlet leads to better moisture removal and coil sizing. ❖