



Air Conditioning for Retail Stores

A Practical Approach

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Many years back, about 25 to be a little more precise, when air conditioning of retail stores was not very common, Rekha, a sari shop in T Nagar, Chennai and Kala Niketan, another sari shop on Queen's Road in Mumbai air conditioned their old existing stores. Customers were delighted, stayed longer, bought more and the shop owners proudly displayed a large sticker on their entrance door "Air Conditioned for your Comfort". These were the first retail stores to be air conditioned in India, to the best of my knowledge.

In those early days, packaged air conditioners were available only in vertical, floor standing, water-cooled models that were placed in a remote corner and concealed from view by wood cabinets to match the store decor. Ductwork was installed above a plaster-of-

paris false ceiling.

About 20 years back, Nilgiris, a small chain of food retail stores started in Chennai and gradually expanded all over the city. All their stores are air conditioned almost from year one. The Subhiksha chain started in 1997 and the Trinethra chain of food retail stores followed much later, once again in Chennai, and each one had its own business strategy to win customers and make a decent profit selling the daily household needs of the middle class families, including vegetables and fruits. To this day, Subhiksha, which claims to be the country's largest supermarket chain with over 300 stores and growing rapidly, considers air conditioning an unnecessary expense and by saving this claims it can offer lower prices to its customers.

Today the retail scene has totally changed as huge glass

fronted malls have sprung up all over the metro cities with massive central plant air conditioning systems running into thousands of tons employing large centrifugal or screw chillers. Department stores, much smaller than the malls are also to be seen in most cities. They are also fully air conditioned with smaller capacity plants running into a few hundred tons. Fortunately for the AC manufacturing industry none of these malls or department stores could have existed for long and flourished were it not for the comfort of air conditioning.

The smaller stand-alone stores

About the Author

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with their contemporary interiors are following the general trend of providing air conditioning in all stores. With tight budgets and strict control over monthly expenses, many owners of small stores or chain of stores will require some guidance on the type of AC systems they should install for best results. This article will attempt to do just that.

What Kind of AC Systems do Retail Stores Need?

Some prominent users and HVAC consultants have defined the following features of an ideal AC system for retail stores:

- Efficient cooling with uniform temperature and good air movement.
- Reliability.
- Low capital cost.
- Low operating cost.
- Minimum space requirement.
- Reasonable indoor air quality.
- Simplicity of installation and maintenance.
- Ease of operation; no need of skilled operators.

What Should the Store Temperature be for Comfort?

This is a good question to start with because deciding this will have an effect on the design capacity of the plant as well as the monthly energy bill. The lower the store temperature, higher will be the plant capacity and energy bills.

Comfort depends on several factors such as temperature, humidity, air movement, clothing worn and activity. Surprisingly, although climates, living conditions and cultures differ widely throughout the world, the temperature that people choose for comfort under similar conditions of clothing, activity, humidity and air movement has been found to be very similar.

The ASHRAE comfort chart depicted in Figure 1, which has been developed after many years of research on thousands of persons in USA, shows the range of temperature and humidity within which most persons feel comfortable.

Consider two examples. In a chemist's store the customer comes for a very brief time period.. makes his/her purchase and leaves and hence the store temperature can be kept as high as 79 to 80 °F without any feeling of discomfort.

In a sari or jewellery shop where the customers tend to stay longer, the store temperature should be lower, say around 77 to 78°F.

While the standard air conditioner can control the temperature (though not very accurately), there is no

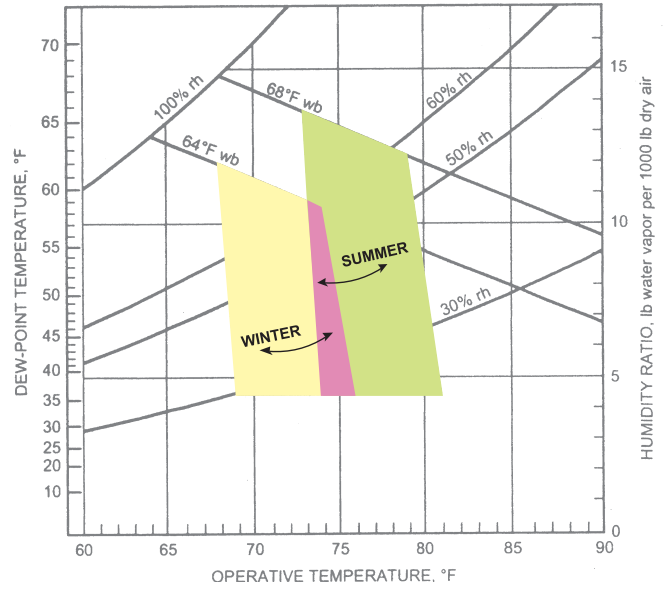


Figure 1: ASHRAE Summer and Winter Comfort Zones (Acceptable ranges of operative temperature and humidity for people in typical summer and winter clothing during primarily sedentary activity.)

direct control of the relative humidity. Most ACs will bring the humidity down to around 65%.

It is best to purchase an accurate dry bulb thermometer along with a hygrometer (for humidity indication) and hang them on a wall in the return air path so that the store manager can learn to sense the temperature and humidity, double check with the thermometer and hygrometer and readjust the thermostat setting on the AC plant.

If you feel that the original thermostat on the air conditioner is not accurate enough, it is best to change to a better thermostat, as this will reduce the energy bills in the long run.

| Star Rating | Proposed Star Rating | | |
|-------------|----------------------|---------------|----------------|
| | From Jan. '07 | From Jan. '08 | From Jan. 2010 |
| 1 Star | 2.30 to 2.49 | 2.50 to 2.69 | 2.70 to 2.89 |
| 2 Star | 2.50 to 2.69 | 2.70 to 2.89 | 2.90 to 3.09 |
| 3 Star | 2.70 to 2.89 | 2.90 to 3.09 | 3.10 to 3.29 |
| 4 Star | 2.90 to 3.09 | 3.10 to 3.29 | 3.30 to 3.49 |
| 5 Star | Above 3.10 | Above 3.30 | Above 3.50 |

Table 1 : Star rating details.

1. The COP should be calculated on the basis of cooling capacity in Watts divided by power input in Watts.
2. The testing of cooling capacity and power consumption are to be carried out as per IS 1391.
3. Range for star rating takes care of 5 % tolerance limit.
4. Same range is applicable for Window & Split AC.

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The new energy efficiency label

What is the BEE Star Rating?

Upto now all decisions made about which AC brand to buy were based mostly on price, service reliability, guarantee period and good looks of the unit. No one gave a thought to the power consumed by the unit in an 8-hour period. With competition hotting up, unscrupulous manufacturers and assemblers would reduce their heat exchanger surface areas to cut costs at the perpetual expense of the buyer who kept paying

his electricity bills month after month at ever-increasing cost of power.

BEE stands for Bureau of Energy Efficiency, an autonomous body under the Ministry of Power, Government of India. Effective this summer season, BEE has started a system of rating room ACs upto 3 ton capacity with a star rating. This will help the buyer to determine which is the more efficient AC, how much extra it costs and how much power it can save. One star is the least efficient and five star is the most efficient. So from now on feel free to ask any supplier of room ACs the star rating of his product.

Though the star rating system is to be followed on a voluntary basis right now, several large manufacturers have already started advertising the star rating they can offer. So from now on don't get sold merely on low price, good looks and how well you know the salesman. Ask for the star rating.

The star-rating program has not yet been extended to ductable split or packaged units of large capacities, but this will happen in future.

Toilet Ventilation - How To Make It Effective?

Every store will have a toilet either for their staff only or both for staff as well as customers. Such toilets must have individual exhaust fans with a capacity of extracting enough air to provide at least 6 air changes per hour. This air can be drawn from the air conditioned store

| Type | Occupancy sq ft/ person | Lights W/sq ft | AC load W/sq ft/ ton | Fresh Air cfm/ person |
|--|-------------------------|----------------|----------------------|-------------------------|
| Large dept. store (Globus, Mumbai) | 30 | 4 - 6 | 120 | 15 |
| Large electronic store (Croma, Mumbai) | 30 | 5 | 120 | 5 with air ozone system |
| Fast food restaurant, Mumbai | 8 | 2.5 | 80-100 | 10 |
| Jewellery store (Maniratna, Mumbai) | 30 | 15 | 70 | 10 |

Table 2 : Check figures for cooling loads

through the bottom of the door to the toilet.

Undercutting the door at the bottom to give you a free area large enough to provide the airflow required at 500 fpm velocity is essential. The fan should be connected to the light switch allowing it to be operated whenever the light is turned on.

A well-ventilated toilet that also has adequate water supply for regular flushing will ensure that no foul odours from the toilet enter the store area. In technical terms, the toilets must at all times be at a negative pressure compared to rest of the store.

An Air Curtain at the Entrance Door - How Does It Help?

An air curtain at the entrance door will help to prevent cool store air spill out every time the front door opens and at the same time prevents insects, dust and gusts of hot air from entering the store.

Care should be taken to ensure that the air curtain is installed properly. The throw of air should not be such that hot air

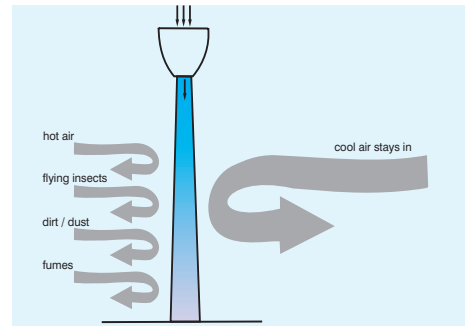


Figure 2: Diagram showing effectiveness of air curtains

gets thrown inside the store. Also, installing an air curtain does not mean that the door can be avoided. Not installing a door would increase the power bills significantly and also result in gushes of hot air rushing inside the store.

Types of Air Conditioners Commonly Available
Window Air Conditioners

These need servicing from the front, occupy valuable shelf space and the air draft hits the customers. Hence, these are normally not preferred or recommended.

Non-Ducted Split Air Conditioners

These are simple to install and maintain and are recommended for small stores. They are available from 0.8 ton to 4.0 ton capacities.

Ductable Split Air Conditioners

These provide uniform cooling without occupying floor space. They are available from 1.5 ton to 17 ton capacities and are recommended for medium to large sized stores.

Packaged Air Conditioners

Packaged units are so called since the compressor, water-cooled condenser if provided, control panel, filter, evaporator coil and evaporator fan are installed in a single

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An air conditioned jewellery store. Notice the bright lights

package or cabinet. In ductable split ACs, the compressor is installed in the outdoor condensing unit and the ceiling suspended indoor unit comprises of the filter, evaporator coil and evaporator fan.

Packaged units provide uniform cooling but occupy floor space. They are available from 5 ton to 17 ton capacities and are recommended for large sized stores.

VRF systems

The biggest advantage of these systems is the variety of indoor units, minimum number of outdoor units and the lowest power consumption as compared to all the above systems. They are available from capacities of 3 ton and upwards to 50 tons. They are recommended for large sized stores.

Recommended Types for Various Store Sizes

Mini stores upto 250 sq ft

Typical of chemist stores, grocery stores, jewellery stores, stationery stores and others.

Split ACs of 1.5 or 2.0 ton are ideal provided there is space to locate the ODU (outdoor unit or air cooled condensing unit) with adequate ventilation air and the distance of the ODU is not too far from the indoor unit or within the limits of the piping length recommended by the supplier.

The indoor unit should be installed at a convenient height so that the air filter can be cleaned regularly without requiring a ladder that can interfere with customers' movements.

A condensate drainpipe, liberally sized to prevent choking, must be connected between the evaporator unit and an external drain point. Should the drain overflow spill out into the store because of a choke, make sure that no goods kept for display or storage below the indoor

* Jewellery stores generally instal very bright lighting for better visibility and display and hence require higher capacity plants.

unit can get damaged.

The copper refrigerant piping should be insulated with tubular insulation and not insulation strips covered with PVC tape, which open out after some time resulting in water dripping from the piping due to condensation.

Stores in coastal cities near the sea front should also check with the AC manufacturer if their ODU's are corrosion resistant, thus ensuring longer life. Else the condenser coils start to leak or have reduced capacity because of fin corrosion and the steel body starts to fall apart because of rust.

Stores upto 500 sq ft

Typical of small textile shops, sari stores, watch stores, jewellery stores, etc.

Install multiple split ACs adding upto 3 tons or 4 tons with same constraints as above.

A few saree stores in smaller cities like Pune, Indore, Nagpur, etc. have the original Indian seating arrangement (Bhartiya Baithak) where customers sit on soft, white-clad mattresses laid on the floor. In such cases, installing the indoor unit high up only wastes power and the ideal level would be 4 to 5 feet from the floor.

Stores upto 1000 sq ft

Typical of small food retail stores including fresh vegetables and fruits, textile shops, sari stores, watch stores, jewellery stores, etc.

Install ductable split units of 7 to 10 ton (for jewellery stores*) capacity with same piping length constraints as above. If ducting is not possible to be laid, install multiple split ACs.

Stores upto 2000 sq ft

Install ductable split units of 14 to 20 ton (for



An air conditioned hobby store with a non-ducted split AC

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jewellery stores*) capacity with same constraints as above. VRF systems can also be installed to reduce power consumption.

Stores from 5000 sq ft to about 9000 sq ft

Typical of large size food retail stores, textile stores, electronic stores etc. Install ductable split units of about 30 to 60 ton capacity with same constraints as above. Packaged units can be installed if space is available. VRF systems can also be installed to reduce power consumption.

Stores of 10,000 sq ft and above

Typical of stores for consumer durables, electronic appliances, books and mini- department stores.

Install ductable split units installed in multiples. Packaged units can be installed if space is available since servicing is easier. VRF systems are more suited here to reduce power consumption.

Cooling Load Check Figures

Table 2 gives some cooling load check figures in Mumbai to help readers a double check their own calculations along with various sources to indicate the current industry practice.

System Design Aspects for Ducted, Packaged & VRF Systems

1. Packaged Units - floor mounted & ductable split units - ceiling mounted

Packaged and ductable split units are generally available with 3 or 4 row deep evaporator coils, which are quite adequate for this segment in view of the moderately high sensible heat ratio.

Unit location

The usage involves locating the indoor units, in designated rooms in the case of packaged units, or on the toilet lofts or above the false ceiling in the passage areas, in the case of ductable split units. Some innovative designers have located the indoor units of the ductable split systems, inside the front signboard of the store, thereby conserving space inside the store.

This is to be expected since space is at a very high premium and the owners / interior designers fight tooth and nail for space. The dilemma faced by the air conditioning engineer is to satisfy them as well as take care of the cooling requirements without compromising on serviceability.

Some design aspects

a) The supply air ducts run in the passage areas and provide cooled and dehumidified air to the various areas of the store through side throw grilles. Air distribution has to be properly balanced through provision of dampers.

b) Alternatively, the supply air duct can run in the

centre of the store, with side throw grilles. This duct can be covered by return air boxing or just a dropped false ceiling, if adequate height is not available. The return air can then be collected by providing a return air grille on the wall of the packaged unit room or below the indoor unit of the ductable split system.

c) If adequate height is available, round ducts can be provided without any false ceiling (to save cost or to give a feel of the height) with grilles provided on the ducts along with small extension pieces to facilitate fixing of the damper in the supply air collars. Grilles



An air conditioned food store

can also be flush with the duct exterior for better aesthetics. However, with this arrangement, volume control dampers cannot be fitted inside the supply air grilles, compromising the air balancing to some extent.

d) Care has to be taken to minimize the noise transmission from the units to the air-conditioned area by:

In the case of packaged units an acoustic lining of the compressor section of the packaged units and by providing an acoustically lined 'Z' piece on the return air wall opening, inside the packaged unit room.

In case of ductable split units an acoustic lining of the enclosure around the indoor units and locating the indoor units over non-critical areas like the dressing rooms or storage area.

e) Store owners should be clearly advised not to block the return air path by improper stacking of goods or creation of lofts within the shop areas.

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f) The lofts have to be airtight to prevent the foul odour from the toilet areas spreading to the air conditioned space. RCC or tile-coba lofts are highly recommended as compared to having trapdoors in the false ceiling since no trapdoor can remain airtight over a prolonged period of time.

g) Drain piping has to be provided with proper slope and u-trap and should be tested before commissioning of the system.

h) With air-cooled units, the outdoor units are normally located on the rear side of the store on wall mounted brackets or RCC platforms provided by the builder.

i) Water-cooled packaged or ductable units can also be used, in the same manner, if quality soft water and space for the cooling tower and pumpsets are available. Care should be taken to ensure that water will be available for at least 10 years.

Benefits to users

Packaged or ductable split units are preferred by users, architects and HVAC consultants due to the following advantages:

- Uniform cooling of the store with proper airflow, subject to care at the design stage.
- Lowest capital cost among all central air-conditioning options.
- Lower operating cost as compared with room or non-ducted air conditioners.
- Fresh air induction is possible, to improve the indoor air quality.
- No floor space requirement, in the case of ductable units. Packaged units require a room, but such rooms are permitted to be excluded from the FSI calculations.
- Simplicity of installation and maintenance.
- Ease of operation; no operators required. Modern day units are provided with microprocessor controllers, which enable single button operation and basic fault diagnosis.

2. Variable flow refrigeration (VRF) systems

VRF systems are the new entrants in this segment, but are becoming more and more popular. The main advantages of these systems are the wide variety of indoor units, lower number of outdoor units and low power consumption.

The indoor units available with these systems are:

- Ducted units.
- Wall mounted units
- Cassette units
- Floor mounted units

Unit location

The usage involves locating the ductable indoor units on the toilet lofts or above the false ceiling in the passage areas or inside the front signboard of the store, as described earlier in the article.

Wall mounted units are generally used for cabins only, since the walls inside the store are used for stacking of goods.

Cassette units are preferred where sufficient height is available (preferably over 3.0 m), since they eliminate the usage of ducting. An additional advantage of cassette units is that fresh air ducting can be connected to these units.

Floor mounted indoor units are used where none of the above options are possible due to the low height or in recessed spaces where an upward throw is desired.

System design aspects

- The system design is very flexible with VRF systems due to the variety of indoor units available.
- The design aspects for ducted indoor units are similar to those described for packaged and ductable split units, earlier in the article.
- Drain piping for wall or floor mounted units has to be planned with care, and preferably done with embedded, insulated G.I. pipes (not PVC).
- The communication wiring should run in G.I./PVC conduits.
- Embedded copper refrigerant piping should be carried out using hard copper piping only.

Benefits to users

VRF systems are becoming popular with users, architects and HVAC consultants due to the following advantages:

- Flexibility of design.
- Lowest operating cost, as compared with packaged, ductable split or reciprocating and scroll chiller system options, resulting in low payback periods.
- Fresh air induction is possible with ducted and cassette indoor units, to improve the indoor air quality.
- No floor space requirement inside the store/showroom.
- Less number of outdoor units for better aesthetics.
- Simplicity of installation and maintenance.
- Ease of operation; no operators required. Indoor units can be operated by remote controllers, similar to those used for non-ducted split units.

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Fresh Air Intake, Indoor Air Quality & Ozone Treatment

These two issues are closely linked and hence they will be discussed together. Fresh air intake is the amount of outdoor air that is drawn into the air conditioner, mixed with the return air and cooled before delivery to the store. The amount of fresh outdoor air required to maintain a good indoor air quality, free of odours, has been debated for many years by experts in hygiene and the debate continues. The National Building Code of India recommends 20 cfm/person while ASHRAE Standard 62.1-2004 recommends for typical office spaces 5 cfm/person plus 0.06 cfm/sft of floor area. If store occupancy of 30 sft/person is assumed (see Table 1: Check List) then according to ASHRAE 62.1-2004 the fresh air intake should not exceed 6.8 or say 7 cfm/sft.

Room air conditioners such as window units and non-ducted splits have no design provision for any fresh air intake. Nevertheless, the frequent door opening in a store where such units are installed brings in enough outdoor air to maintain acceptable indoor air quality. Packaged ACs, ducted splits and cassette type indoor units in VRF systems do have provision for introducing outdoor air to maintain indoor quality for the average store.

However, certain stores that sell fresh food and also have very large crowds of shoppers on some days or at certain times, are unable to provide enough outdoor air to maintain that feeling of freshness at all times. Big Bazaar in Mumbai is a good example. Another store, Croma that sells all types of electronics and appliances, finds that the odours emanating from all the synthetic materials stored as well as volatile organic compounds (VOC) emitted from certain products, cannot be neutralised by the fresh air drawn in by its air conditioners leaving behind a lingering feeling of staleness in the store. The installation of Ozone generators in these stores has had a marked effect in improving the indoor air quality, so much so, that one store owner has noticed an increase in useful footfalls i.e. an increase in sales turnover after the installation of the Ozone generator, possibly since customers tend to stay longer in stores that have a better indoor air quality.

Conclusion

Air conditioning of retail stores is relatively new in India. There is no doubt that this segment will grow enormously in future and there will be pressure from large retail chains to reduce capital costs as well as recurring costs on power consumption and maintenance. Reliability of operation and speedy service in case of breakdown will be other issues that will figure prominently in the list of essentials that buyers will demand. ❖