Building Services III
Lecture 4

Types of AC Systems

Now, we will move on to the types of air conditioning systems. The major two types are; Central AC systems and Non-Central AC products. In this lecture we will be talking about these non-central ACs like window ACs and split ACs. If we look into split air conditioners, they are further subdivided into - Floor mounted, wall mounted and ceiling mounted. The ceiling mounted is further subdivided into Exposed type, concealed type and semi-concealed type or the cassette type. First, the window air conditioner. Even though this window air conditioner has become a thing of the past in today's context, we still look at how it works and why in the first place do people go for window air conditioners? The window air conditioner comprises of the compressor, the condensor fan, the evaporator, all are enclosed in a single cabinet. The unit has to be installed on a wooden frame, either via the window or through a hole in the wall. The air is being blow through the condenser, pass freely through without obstruction. We must therefore make sure that the condenser is not obstructed, for example, by a neighbouring wall. The condenser is placed on the exterior part, what it means is, the external part of the air conditioner which projects outside the wall must not be obstructed by any wall or any other feature. These airconditioners come in cooling capacities from 0.5 to 2 tons in various tonnages, adequate for a room between 5 and 20 square metres in size. Larger spaces may be handled by using multiple units of this type.

The next is the Split air conditioners which are very famous and common thing in today's context. Almost everyone has a split air conditioner in their room. As the name implies, a small portion is projected within the room and a small portion outside the room, because of which there were a lot of security issues. People tend to rob the window air conditioner. Sometimes, they tamper with it, sometimes it falls down, there are a lot of issues with window air conditioner. That's why Air Conditioning companies came up with the idea of Split Air Conditioners. The basic difference is that it has two basic components, the Indoor unit and the Outdoor unit. These two units are connected by refrigeration tubing and electrical wires that can pass through a hole in the wall barely 10 cms in diameter. You can drill a small hole in the wall to draw these pipes, that is sufficient and there is a flexibility in placing this air conditioning system, both the indoor and outdoor unit. You can put the outdoor unit wherever you want, it is not necessary that you have a very large window or a big opening and the outdoor unit can also be located on the terrace or wherever you want. This the major reason why, people opted for split air conditioners. The outdoor unit houses the compressor, condenser and the condenser fan. The indoor unit consists of the evaporator (cooling oil) and the evaporator blower. Since the noisier components are outside the building, the conditioned space is much

quieter. This is an added advantage while using a split airconditioner. As we saw, there are three types of split airconditioners. First is the floor mountain, another rather the indoor unit, we have the floor-mounted unit. Such units are mounted on the floor, maybe on a platform. The Air throw is upwards. Since floor-space is premium and floor-mounted units occupy real-estate, such indoor units are not very widely used nowadays.

Next is the High Wall splits. You might have seen these in almost every home, offices; wherever you go, you see one of these. Such units are fixed on the wall, at a height of about 2.5 metres from the floor. The controls are generally operated either by a corded or cordless remote control unit. Because it is mounted on the wall, it is preferred for rooms having less floor space. This model is widely used for domestic and commercial applications.

Next comes the Ceiling mounted. This is further divided into three types; Exposed, Concealed and Semi Concealed. The Exposed - these units are fixed directly on the ceiling and are visible. The unit is similar to the floor mounted type. They are easy to mount and are preferred in commercial areas or offices that do not have a false ceiling. They also call it Turbo Split. These days, ceiling mounted ACs are available in much larger tonnages, 5 TR capacities to serve the cooling needs of large halls and showrooms. These are also called as Turbo splits.

Next come the Concealed, ceiling mounted split units. These units are also mounted on the ceiling but are designed to be hidden. They are generally concealed by a panelled box or false ceiling. These units are suitable for commercial areas where the interior design requires air conditioning equipment to be concealed so as to not interfere with the aesthetics. You will find such units working in restaurants and offices.

Next and the final types will be the Cassette unit. You might have seen these units in high end offices and high end showrooms. These Cassette units are mounted above the false ceiling, in such a way that the outlet grill of the unit is flush with the bottom of the false ceiling. While the other types of indoor units provide for condensate draining by gravity, the same is not possible for the cassette type. To overcome this problem, a small motorised pump is employed to drain out the condensate water.

What is condensate water? When the air around the evaporator is cool, the moisture and the air accumulate as water under the evaporator. This happens since the cold water cannot hold as much as water vapour it held when it was warmer. You experience the same phenomenon when a small puddle of water accumulates under a chilled glass of water. Take a cold water, put it on the glass and put it on the table. The water droplets surround the glass or a cup as such. This is condensed water. Usually, this condensate water is collected in a pan under the evaporator and must be removed from te conditional space.

Therefore, wherever Indo units are mounted, there must be a gentle sloping drain tube to carry the condensed water away from the room. If the water is not drained properly, it will collect in the drain pan, until the over frozen drips into the room. This is the primary reason you see in many commercial spaces or even houses. Where houses aren't maintained or cleaned properly, the water starts dripping from the air conditioner. In a Cassette unit, because it is placed in a much interior part of the building and a long length of piping gets connected to the outdoor unit, this condenser water also has to travel the distance. Hence, we have a pump which can help pump this water out.

Applications for Non-Central AC Products

Next, let us look at the Applications for Non-Central AC products. We can quickly summarize, the Window ACs, floor mounted splits, High wall splits and in Ceiling mounted splits, we have exposed, concealed, semi-concealed or Cassette type.

Window Acs can be characterized by the following positive and negative features. The positives being; Inexpensive, easy to install, each room can operate its AC independently. Simple, low-cost service and maintenance. Running costs are low when compared to other types. Negatives are; Tonnages are limited - 1 or 2 TR typically, noisier than other types of ACs. A window is required and is blocked by the AC and there is no constant fresh air circulation. These are the negatives of this type. Keeping the above attributes in view, window ACs are useful in homes, small office executive cabins and small shops. Next will be the mini split ACs. All the mini split ACs whether floor, wall or ceiling mounted, they have the following positive aspects; they are quieter than Window ACs, available even up to 5 Tonne. They do not require or block a window. You can use it to cool 2 or 3 adjacent rooms. They may suit the interiors better and they are also aesthetically pleasing. The negatives would be - they are slightly costlier than window ACs. In today's context, sine window ACs have phased out, so many people have opted for splits and the split is the cheaper and basic air conditioner type available in the market. They require a space outside the room in the outdoor unit. There is some piping and cabling required, which was not in the case of window air conditioner and they also do not provide fresh air intake. Keeping these in mind, these type of split ACs can be used in senior executive cabins, professionally positioned small or mid-sized showrooms; Upmarket homes and Small clinics and ATMs. Irrespective of this, it is used in most of the places. Now, we will move on to the second major type i.e the Central ACs. In this lecture, we will only look into Ductable packaged ACs. The Central plants will be looked into in the next lecture.

This Ductable Packaged Airconditioners come in two types; Air-cooled ducted splits and the other is the floor-mounted packaged air conditioners. Once again, these floor-mounted packaged air conditioners are of 2 types; air-cooled type and water-cooled type.

Air-cooled Ductable split - where do you use these? As we saw, the splits can be used in a single unit or in multiple rooms you put multiple units. Whereas now when there is a huge office space like around 1000 sq ft and you have few partitions like one is an empty cabin, one is a conference room, another is an open work area, etc. Now, you could choose to go for individual split units, no harm. But still, the load which you have to calculate will be much larger when you use individual splits. Rather, when you opt for ductable splits, put the entire load in the spit unit and use it for different spaces. Naturally, no space will be fully occupied all the time and no AC will run on full load the entire day. Some spaces like the conference room, the empty cabin, might be used only for few hours of the day while the work area will be used throughout the day. When we go for the ductable splits, there is an option of using the wasted load or unused load in these usable spaces, thereby causing a huge save in the initial cost and also on the working cost.

Let's look at how these air-cooled ductable splits work. The indoor portion of these units are located above the false ceiling and are connected to the ducting. Consequently they do not occupy floor space.These ductable splits as their name suggests, the AC is distributed via ducts and the unit is one large machine or a unit that is placed hidden inside the false ceiling. You can locate this unit where there is easy access to maintenance and all other spaces, AC is supplied via ducts. Currently in India they are available in 3,5,7.5 & 8.3 Ton capacities. Since the indoor unit is located above the false ceiling, the space available limits the capacity to 8.3 Tons per unit. As I said, great care must be taken to select the location of the indoor units. Ideally, they must be located in the corridors, above lofts, etc, where accessibility is not a problem. If the units are located in the conditioned area, attending to machines can cause disturbances to the working area. False ceilings in the decorated interior areas may look aesthetically unappealing due to the trap door provided for maintenance. You might have seen this in many commercial unit establishments, where they've put the unit inside the office space and then you can see a trap door, some fingerprints and dirt around the trap door. This will spoil the interior look. This is how it will look, the picture shows the indoor unit and the ducts that carry the AC to different areas.

This is the entire setup of this air cooled ductable split. Here you see this duct that takes in the air into the interior spaces and then the Refrigerant piping and dain piping that get connected to the condenser of the outdoor unit here. It has its own components such as the local switch, control wiring, etc. Using a remote control, wireless or wired remote control, you can switch it on or switch it off.

Floor-Mounted Packaged Units

These types are commonly used in marriage halls and cinema theatres. This looks like a big cupboard and are typically placed in a small enclosure adjacent to the conditioning areas. Inside this 'cupboard' like enclosure is housed the compressor, the evaporator and the evaporator blower. Currently in India these units come in capacities from 5 to 16.5 Ton machines. Higher capacities such as 20 Tons and above can be expected in the following years.

These floor standing packaged airconditioners come in both Air-cooled and Water-cooled model. What is the difference? The water-cooled units use water, this water is used to cool the refrigerant and the condenser. Water is pumped through the shell and tube condenser which are a part of the packaged unit. This unit is then send to a cooling tower outside the air-conditioned room where the heat is dissipated to the atmosphere. Water-cooled units give higher capacity and are more energy efficient due to lower operating pressure. In the Air-cooled models, there are suitable where water is scarce or hard quality or there is no space to install a cooling tower. Here, in this type, the heat is removed via the air-cooled condenser with a fan blowing through it. This condenser unit is outside the building or on the terrace. This is pretty much the same type of condenser you use for a split air conditioner, normal high wall split. This is the entire setup of a water-cooled floor mounted packaged air conditioner. Here, you see this floor mounted unit is put in a conditioned space and then, ducts distribute the cold air to the different spaces and these are connected to the outdoor unit where the pump, your compressor, everything is placed. In turn, the drain water or the water that cools this condenser is connected to this cooling tower setup. We have already seen in lecture 3 about how a cooling tower works. The hot water goes to the cooling tower and it is thrown into the cooling tower as small droplets and through a natural force draft it is cooled. Once again, it is collected at the bottom and then sent back to cool the refrigerator. This is the layout or the setup of air cooled conditioner. This is pretty much similar to the split airconditioner. This is the indoor unit and the ducting portion and pipes connecting to the outdoor unit and this is cooled by air. Though they require a small plant room, they have some good advantages. They are service friendly because of easy accessibility. They can handle longer ducts by virtue of having more powerful fans. Large tonnages can be handled with less units. Interiors are clean and undisturbed since the machines are located in a separate plant room. Of Course, you need a small room but when you compare it with other air conditioners, it is better to go with this type of air conditioner.

Let us look at the applications of Ductable Packaged ACs. Ducted splits can be characterized by the following positive and negative features; the positives are, they are ceiling mounted. Hence, no space is needed. They are available in lower tonnages from 3 TR onwards. Ducts can carry cool air to every corner/room of the space that needs cooling. Fresh air can be injected. There is a provision for fresh air to be included or injected into the air-conditioned space. The

negatives are; when you go for a higher side for higher tonnages, they are limited to 10 TR and the service and maintenance are inconvenient, because of this ceiling mounted unit. Here, this mounting of the indoor unit requires careful planning. If located above the pantry or the wash areas, smells may be spread into the cool space> If located above executive cabins, service may become a problem. Hence it is better they are located on corridors or other common areas. Removal of condensate water may cause problems. Keeping these in view, you can use them for offices, restaurants, banks, showrooms, clinics, bars which are concerned about fresh air induction and removal of smells and medium sized rooms like 500 to 1500 sq feet. In larger space you can use multiple units which do not have the plant room space that a packaged AC will need. Even larger spaces, you can opt for these ducted splits but with multiple units. When coming to packaged ACs and the floor mounted ACs, they are available in much larger tonnage range. Multiple units can aircondition much larger spaces. Conveniently located in separate plant rooms. They can service and maintain without troubling inmates. Fresh air is best circulated using these machines. Drainage of condensate water poses no problem. There is only one negative which is, it requires a separate plant room dedicated for the machine.

Once again, keeping these in mind, you can use the packaged ACs in Offices, showrooms, hospitals, clinics, restaurants, shopping malls, banks which are larger than 2000 square feet, critically concerned about fresh air and constant 'air changes' and needing ducting to carry cooled air to various rooms and even floors within the cooled space. You can even go across multiple floors with these type of ACs. Finally before closing, let us look at the insulation practices for air-cooled units. What are the good practices? As we saw, in the split units' layout, it needs the refrigerant piping or the drain water pipe that runs between the indoor unit and the outdoor unit. Looking at the copper pipes that carry the refrigerant. We know that the indoor unit of any split air conditioner is connected with the outdoor unit through refrigerant piping. Most often, imported copper pipe is used for this purpose. It could either be soft drawn copper tubing where this can be used for a single phase non ducted split air conditioners or the Hard drawn, L-Grade Copper tubing that is used for 3 phase ducted splits/ packaged units.
The first point is about the length of the interconnecting pipe. We must always ensure that the right distance is always maintained between the indoor unit and the outdoor unit. There are limits to the distance between them imposed by the equipment design. Based on the equipment design you have some maximum units where you use these indoor and outdoor units. As the distance between the units increase, the following happens; The refrigerant pressure drops, resulting in decreased cooling capacity. The lubricating oil does not return to the compressor easily, leading to compressor damage, where you can go for an oil trap every 3 metres and so on. This helps to return the lubricant to the compressor along with the return gas and the extra refrigerant required by long tubing can lead to un-evaporated liquid

refrigerant flowing into the compressor thereby damaging it. You have to keep all these in mind while deciding the length of the tube.

Here are a few graphics that explain this point; first is avoid big height difference between outdoor and indoor units. ; avoid too many bends in the piping and avoid long interconnecting piping. As we see, this piping that connects the indoor and outdoor unit, runs exposed and because this copper tube carries the refrigerant, there is certain amount of insulation that is required to maintain the temperature of this refrigerant for effective or efficient functioning of this air conditioner. The refrigerant piping carrying gas from evaporator to the compressor is known as Suction line and the piping carrying liquid refrigerant from the condenser to the evaporator is known as Liquid line. By insulating the pipes together, the suction line will carry only dry gas required for compression and the liquid line will carry on liquid for expansion or evaporation.