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**Ducted Splits
for Special
Applications**

A custom-built AHU for a micro-biology lab in a pharma plant connected to a standard condensing unit.

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Factory-built standard ducted split air conditioners are designed for normal comfort applications in offices, retail establishments, restaurants, large residences and the like. In the absence of reputed manufacturers of simple air-cooled condensing units with weather-proof enclosures, the outdoor unit of the standard ducted split AC, manufactured by several large companies, can double up as a condensing unit, which when coupled to an

engineered evaporator unit can be used to condition a variety of special applications beyond the reach of the standard ducted split AC.

Such special applications include clean rooms, operation theatres, low humidity areas, high air quantity server rooms and many others, limited only by one's engineering design capabilities and the standard capacities of factory-built ducted split ACs.

The Standard Ducted Split Unit

To start with, let us look at the range of operation of the commercially available ducted split units:

- The range of operation in most rating charts is 70°F to 80°F and 50% to 60% relative humidity. The ADP would be in the range of 50°F to 60°F.
- Most ducted splits have dehumidified air quantity in the range of 400 cfm per ton.
- The external static available at the outlet of split units is in the range of 10 mm wg.
- The cooling coils generally have 12 fins per inch or more and are 3 or 4-rows deep.
- Many ducted split unit models have a capillary expansion device instead of the thermostatic expansion valves.
- In ducted splits, the compressors are in the outdoor units. The refrigerant pipe length is a source of capacity derating. More importantly, a long suction line could result in oil return problems.
- Many ducted split unit models today come with multi-compressor options to address compressor redundancy issues and capacity control for part load operation.

Special Requirements

The above characteristics address the requirements of many comfort applications encountered in offices, shops and residential establishments. However, these become constraints that preclude the use of ducted splits in special purpose applications.

- Low humidity applications may require ADPs as low as 40°F to maintain inside conditions of, say 70°F and 40%RH. The corresponding dehumidified air quantity may be of the order of 250 cfm per ton. Such requirements are frequently encountered in pharmaceutical and hospital applications.
- In high dust-generation areas, cleanability of cooling coils is an important consideration. Here, cooling coils with 12 fins per inch and having anything other

than straight plate fins will only result in difficulty in cleaning. Coils with 8 fins per inch and plate fins definitely eases coil cleaning.

- In high equipment load areas encountered in server rooms and in many manufacturing applications, the cfm per ton could be 600 or even more.
- In many applications, ducted returns are a must. There might also be a requirement of fine filters or hepa filters. All these require powerful fans that need to develop anywhere up to 150 mm wg. static.
- Some buildings have constraints in the location of outdoor units and as a result the distance between indoor and outdoor units may be very large. This could result in oil return problems due to a long suction line leading to compressor failure.
- The capillary type expansion devices may not adequately serve widely varying air conditioning loads and abnormal ADPs.

Why would a designer want to use ducted splits in the above applications? The fact is that the ducted split is a standard piece of equipment. If a factory or an establishment does not already have a central chilled water facility and has a requirement of special duty for a relatively small area, the ducted split adopted for the application would be an ideal choice. This would be a very economical choice in terms of first cost, in terms of not needing plant room operators and also at no extra electricity cost compared to central plants.

The idea is to use the ducted split in these applications without mutilating its components that require maximum maintenance and which are primarily located in the condensing unit.

In most cases, the cooling coil and controls et *all* are shifted to an air handling unit. In special cases, expansion valves replace capillaries and where required, the standard cooling coil, air filters and blowers are replaced with a special selection.

Using Ducted Splits for Special Applications

Here are a few applications where the condensing units of standard ducted splits have been actually used and have been in operation for several years.

Clean Room Applications

These applications are characterized by a high static pressure requirements for the evaporator blower on account of air filtration. To achieve the desired cleanliness conditions, various grades of filters are used in air handling units. The filters placed in series are “coarse” (EV3/EV4), “fine” (EV6/EV7) followed by plenum mounted “hepa”

bank (EV8/3V9... EV11). In addition there could be terminal “hepa” filters. Further, the air-handling units should incorporate GMP features.

Good Manufacturing Practice (GMP) is a term used in the pharmaceutical industry. In relation to the airhandling units, this relates to easy cleanability of the various components of the units viz. filters, cooling coils, heating coils, drain pans etc. It also means that there should be no sharp corners where dust can accumulate.

Figure 1 shows a ducted split with the outdoor unit (condensing unit) intact and the cooling coil placed in an air-handling unit for a typical clean-room application. There are two DX cooling coils, each connected to an independent compressor. The two compressors in the outdoor unit are used to advantage for redundancy and capacity control for part load operation.

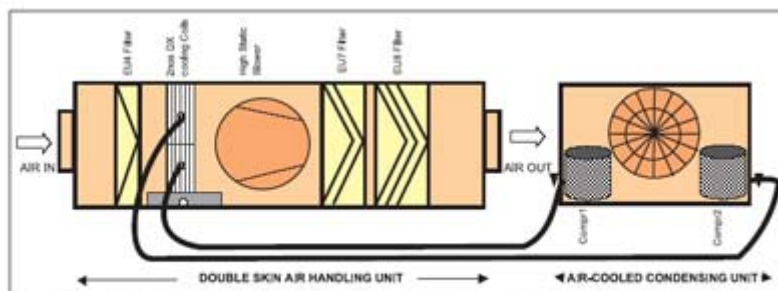


Figure 1: A standard air-cooled condensing unit combined with a high pressure double skin air-handling unit for clean-room application.

The air-handling unit here has three banks of filters: EU4 return air filters, EU7 fine filters and EU8 hepa filters.

Typically, the blower static in this application would be around 100mm wg.

High Sensible Load Applications

Server room air conditioning frequently requires dehumidified air quantity in the range of 600 cfm/ton. There are also high-equipment-load industrial applications that require such high air quantities.

In such applications, to size the ducted split as per the dehumidified air quantity will result in an oversized condensing unit. The compressors would trip very often resulting in reduced compressor life and wild temperature swings. The right way would be to size the evaporator and cooling coil as per dehumidified cfm and the condensing unit as per the heat load.

Figure 2 shows a high sensible load application. The outdoor unit is a standard 5 ton unit and the indoor unit is a standard 7.5 ton unit with 5 ton customized cooling coil. The 7.5 ton indoor unit delivers 3000 cfm.

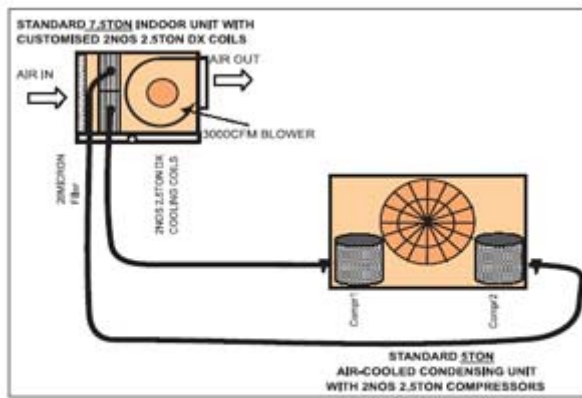


Figure 2 : A standard 5 ton condensing unit combined with a standard 7.5ton indoor unit with customised 5 ton cooling coil designed for 600cfm/ton.

The combination of units thus works out to 3000 cfm for 5 tons i.e. 600 cfm per ton. A similar combination of 3 ton outdoor with 5 ton indoor of 2000 cfm results in upto 667 cfm per ton.

Several other combinations may be used.

Applications with Controlled Humidity

Figure 3.1 shows an RH-controlled application. The standard condensing unit is coupled with a customized cooling coil placed in an air-handling unit. A heater bank is placed after the cooling coil. The heater bank is provided for the purpose of RH-control.

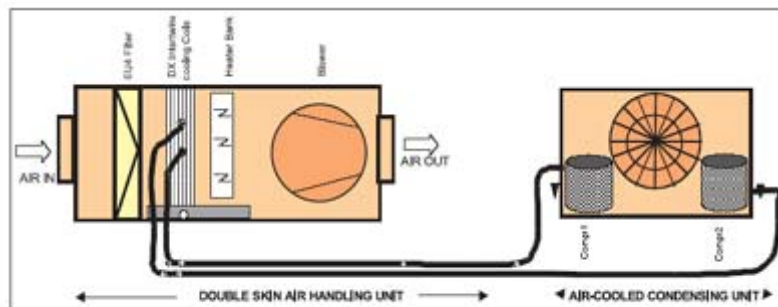


Figure 3.1 : A standard air-cooled condensing unit combined with a high pressure double skin air-handling unit for RH-controlled application.

When designing a cooling coil for an RH-controlled application, there are some important issues relating to dehumidification. The main consideration is that dehumidification should occur at all times, during full load as well as part load.

Figures 3.2 and 3.3 show design options for cooling coils for RH-controlled applications. The face split coil, as shown in **Figure 3.2** is commonly used. However, this configuration has a drawback during part-load operation. A portion of the air bypasses dehumidification during part load as it flows over a part of the coil that has no cooling because of the connected compressor having cycled “Off”.

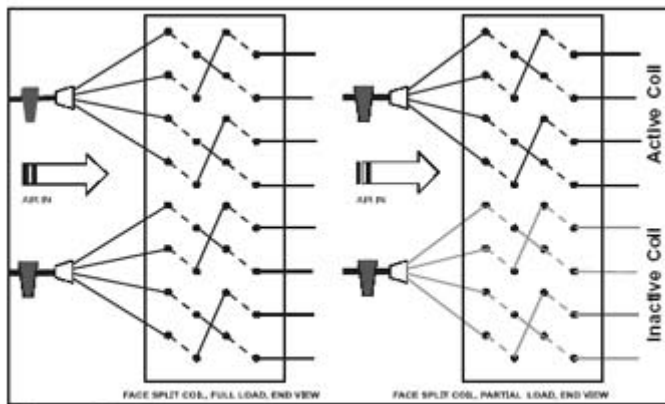


Figure 3.2 : Face split coil in operation during full & part load.

The intertwined full face active coil, as shown in **Figure 3.3** is a preferred choice for RH-controlled applications. Even during part-load operation air always passes over cold tubes even when one of the compressors has cycled “Off”.

The dark lines refer to the active refrigerant circuit. The faint lines belong to a refrigerant circuit, which has cycled “Off”.

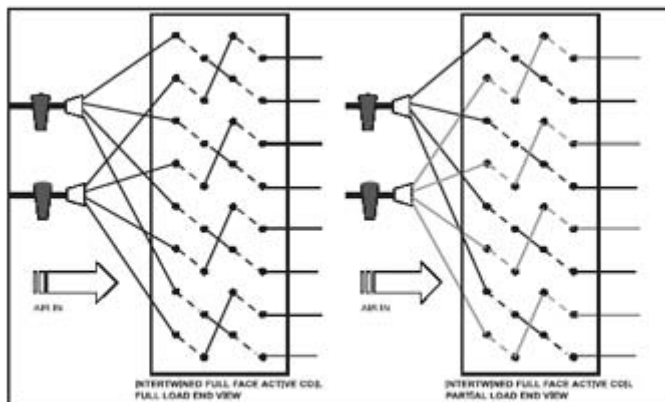


Figure 3.3 : Intertwined full face active coil in operation during full & part load.

Applications with Long Refrigerant Piping

Many architectural constraints require applications with long separation between indoor and outdoor units. This could result in oil return problems with the suction line and consequent compressor burnout.

Figure 4 shows an application where the distance between the indoor and outdoor units is inordinately long. All the standard ducted split components have been retained in this example. However, the compressor has been shifted from the outdoor unit to a separate location near the indoor unit in order to shorten the problematic suction line. An installation has been carried out with 3×5 ton ducted splits in this manner with indoor units on the 3rd floor and outdoor units on the terrace of the 7th floor and refrigerant piping length between indoor and outdoor units in excess of 125metres. This installation

used for server room air conditioning in Mumbai has been running trouble free for more than one year.

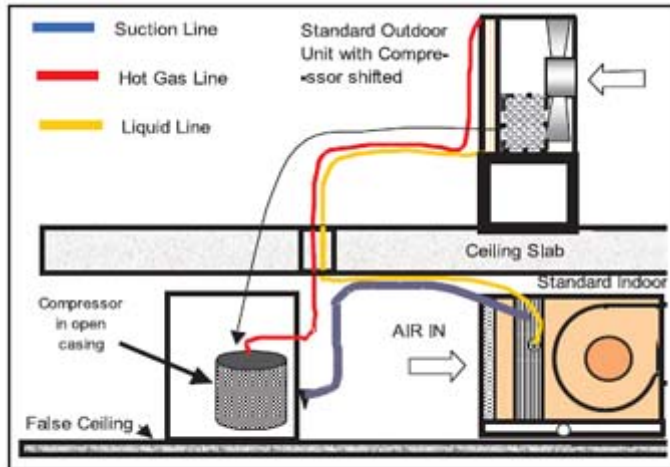


Figure 4 : A standard condensing unit combined with a standard indoor unit with the compressor shifted indoors to reduce the suction line length.

The installation being in a Heritage building, there were limited options for installing the outdoor units. It goes without saying that in such an installation, equipment derating will need to be accounted for.

Conclusion

The key to using ducted splits in many of the specialized applications is the cooling coil selection. This has to be done from the basics or the coil procured from one of the engineering coil vendors. Mr. A. B. Marathe has covered the design of cooling coils in the Oct.- Dec.'02 issue of the *Air Conditioning and Refrigeration Journal* and this can be used for reference.

It is also imperative that while designing for these applications, the performance characteristics of the indoor units and the condensing units are known.

The condensing unit characteristics give capacity and power consumption of the units for various suction pressures and outside ambient temperatures. When using only the condensing units, this information is adequate.