Dual-Duct/Dual-Fan Systems

System Description

Dual-duct/dual-fan systems are a variation of the more traditional dual-duct system. There is a dedicated cooling air handling unit and a dedicated heating air handling unit. Both units are variable air volume (VAV). Each unit is ducted to mixing boxes for each zone.

The cooling air handling unit provides each zone mixing box with conditioned air at a constant temperature (typically 55°F). The amount of air is varied to match the heat gain from equipment, lights, exterior and people loads. At part load conditions, the mixing box only supplies the minimum amount of conditioned air necessary to each zone, resulting in significant fan energy savings.

In heating mode, the mixing box reduces the cold air volume to minimum and then modulates the hot air volume to meet the space conditions.

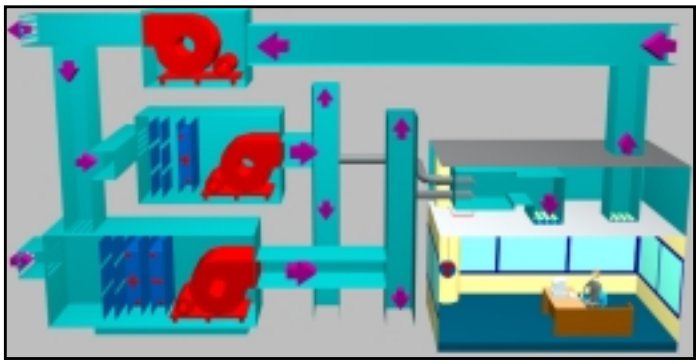
As the mixing boxes modulate the hot and cold air, the duct system static pressures change. The supply fans are then modulated to maintain duct static pressure either by discharge dampers (FC fans only), inlet guide vanes, or variable frequency drives (VFDs).

Heating Requirements

The heating air handling unit supplies heating to the zones as overhead heating In most cases perimeter baseboard heating can be avoided, offering first-cost savings. The heating unit is usually a recirculating unit only, without any ventilation air. It is possible, with DDC controls, to vary the supply air temperature of the heating air handling unit from recirculating plenum air (no heat added) to maximum heat required for the coldest zone.

Air Handling Systems

The cooling air handling unit can incorporate either air- or water-side economizers to take advantage of free cooling during mild weather. It may also have a preheat coil to provide the proper supply air temperature in cold weather.



The air handling systems can be either blow-through or draw-through. Blow-through units add the fan heat (usually equivalent to 2-3°F) before the cooling coil. The leaving air temperature from the cooling coil then becomes the supply air temperature. This provides the maximum temperature rise between the cooling air and the space design temperature. (The least amount of supply air will be required.) Since the air is often fully saturated and moisture may be an issue, blow-through should not be used with final filters downstream of the coils.

Draw-through units typically require 10% more supply air than blow-through systems for the same temperature off the cooling coil. This will increase duct size and fan operating cost. The fan heat will ensure the supply air is not fully saturated, avoiding moisture issues.

IAQ Considerations

ASHRAE Standard 62.1-1999, Ventilation for Acceptable Indoor Air Quality, provides a procedure for calculating the minimum outdoor air volume for a system serving multiple zones.

Ventilation air is introduced at the cooling air handling unit. Two issues occur with VAV systems. First, as the total supply air to a space is reduced, the percentage ventilation air is also reduced. The central air handling system must be able to maintain a fixed amount of outdoor air while varying the supply air volume. Technology such as DesignFlow™ can be very helpful here.

Secondly, different zones will require different percentages of ventilation air, but the centralized air handling unit can provide only one outdoor air ratio.

System Pros

- Only the required amount of supply air is used, so fan power is not wasted.
- There is no simultaneous heating and cooling. Heat in plenum air can be used as reheat.
- Fixed cold air supply temperature maintains humidity control in space.
- Air- or water-side economizers can be added easily to the design to avoid mechanical cooling during cooler weather.
- The main air handling systems can accommodate the ventilation air, avoiding dedicated ventilation equipment.

System Cons

- Two ducting systems and two air handling units add to cost.
- Introducing the correct volume of outdoor air into the building is more difficult.
- Providing each zone with the correct amount of outdoor air is more difficult.
- More sophisticated controls are required.
- Large duct shafts from centralized air handling systems are required.

Energy Considerations

Since the fan systems are VAV, there is significant fan power savings. Reheat is in the form of recirculated air, which is also efficient. Generally, the return air fan system has better mechanical and motor efficiency than the small fans used in series fan-powered VAV systems. The following are some considerations outlined in ASHRAE Std 90.1-1999. The numbers in brackets refer to Std. 90.1-1999 sections.

- Energy efficiency tables for HVAC equipment (6.2.1).
- Equipment must be scheduled off automatically during unoccupied hours (6.2.3.1).
- Demand Controlled Ventilation is required for systems with at least 3,000 cfm of outdoor air and occupant density greater than 100 people per 1,000 ft^2 (6.2.3.9).
- Air- or water-side economizers are required. There are several exceptions to this rule, particularly when dealing with heat recovery (6.3.1).
- Where humidification is required to maintain humidity above 35°F dewpoint, water-side economizers must be used when economizers are required. Introducing large amounts of cool, dry air while meeting the sensible cooling load adds significantly to the humidifier load. Process loads, including hospitals, are exempt (6.3.2.4).
- For systems under 20,000 cfm, VAV is limited to 1.7 hp/1,000 cfm. For systems over 20,000 cfm, VAV systems are limited to 1.5 hp/1,000 cfm (6.3.3.1).
- 30 hp and larger fan motors must use no more than 30% of design power at 50% airflow (6.3.3.2).
- Energy recovery is required for systems with at least 5,000 cfm supply air and a minimum of 70% outdoor air. This is specifically aimed at schools and labs (6.3.6.1).

A thorough explanation of the Standard is beyond the scope of this document. The designer should have access to the Standard and a complete understanding of its contents. The ASHRAE 90.1-1999 Users Manual is also very helpful. ASHRAE considers Standard 90.1-1999 a high-profile standard and continuously updates it.

Typical Applications

Dual-duct/dual-fan systems are excellent for retrofitting traditional dual-duct systems. Dual-duct systems use a large of amount of fan energy and have simultaneous heating cooling. Both problems can be solved with a dual-duct/dual-fan system.

Common applications include:

- Office Buildings
- Institutional

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