VAV with Reheat Systems

System Description

Variable air volume (VAV) with reheat systems provide conditioned air to each zone at a constant temperature, typically 55°F. The amount of air varies to match the heat gain from equipment, lights, exterior and people. At part load conditions, VAV systems supply only the necessary amount of conditioned air to each zone, saving significant fan energy.

A damper (such as a pre-manufactured VAV box) adjusts air flow at each zone. A temperature sensor located in the space adjusts the damper to maintain the room temperature setting.

When more dampers close, the duct system static pressure increases. The primary supply fan adjusts to maintain duct static pressure using discharge dampers (FC fans only), inlet guide vanes, or variable frequency drives (VFDs).

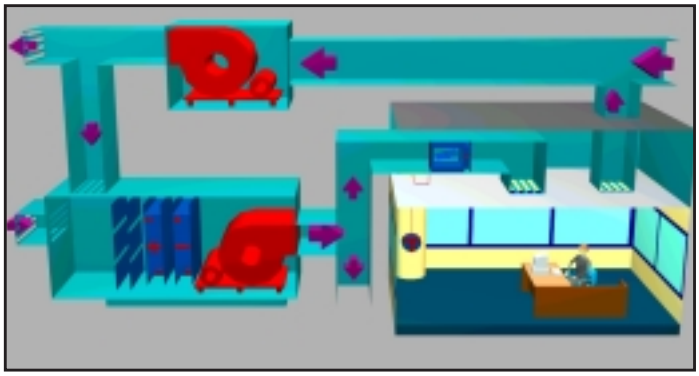
Heating Requirements

The supply air temperature of a VAV system is usually constant at 55°F and only cools a space. Ambient conditions and minimum supply air rates can create a need to heat a zone. Perimeter zones often include baseboard or radiant panel heat that directly affects the space. Adding reheat in the supply air stream (electric heaters or hot water coils) is also possible, but the air distribution system must be designed carefully. Most interior zones use reheat in the air stream if necessary.

Air Handling Systems

VAV systems require an air handling system such as the Vision™ air handler, rooftop, or vertical self-contained units. Most can use either air- or water-side economizers to take advantage of free cooling during mild weather.

Air handling units can be either blow-through or draw-through. Blow-through units add fan heat (usually equivalent to 2-3°F) before the cooling coil. This maximizes the temperature rise between the cooling air and the space design temperature or minimizes the amount of supply air needed to condition a space. Since the air is often saturated and moisture problems may occur, a blow-through design should not be used with final filters downstream of the coils.



Draw-through units add fan heat after the cooling coil and typically need 10% more supply air than blow-through units to achieve the same zone cooling effect. This added supply air increases the duct size requirement and fan operating costs. Moisture is less of an issue with draw-through units because the fan heat helps to reduce the saturation of the supply air.

IAQ Considerations

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

VAV systems present unique challenges in maintaining minimum outdoor air quantities:

- Minimum outdoor air quantities are typically fixed. VAV systems vary the amount of supply air. As the supply air decreases, the percentage of outside air in the supply air stream must increase. Direct measurement of outside air quantities, such as that provided by a DesignFlow™ system, can help maintain minimum outdoor air quantities throughout the operating range of a VAV system.
- Different zones need different amounts of outside air, but centralized air handling units provide only one outdoor air ratio.

Minimum Turndown

VAV boxes can be set to provide a minimum amount of air, even if that amount exceeds cooling requirements. While this maintains air turnovers and minimum outdoor air ventilation rates, the zone may be overcooled and reheat may be required, resulting in simultaneous heating and cooling. ASHRAE Standard 90.1-1999 requires the minimum supply air volume be the ventilation rate for the zone for most applications.

System Pros

- Only the necessary amount of primary air is used, conserving primary fan power.
- Diversity is applied to supply air volume, reducing duct and fan sizes.
- Air- or water-side economizers can be added easily to the design to minimize mechanical cooling during cooler weather.
- Air handling unit can maintain minimum outside air amounts, avoiding the need for dedicated ventilation equipment.

System Cons

- Difficult to consistently maintain minimum outdoor air quantities entering the building.
- Difficult to consistently maintain the correct amount of outdoor air in each zone.
- Requires sophisticated controls.
- Large duct shafts are needed.
- Simultaneous heating and cooling occurs once the minimum air volume is reached in a zone.
- A separate, distributed heating system is needed for cooler climates.

Energy Considerations

Varying the supply air volume reduces fan work, a major use of building energy. 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 (6.2.3.2).
- Demand Controlled Ventilation is needed for systems with at least 3,000 cfm of outdoor air and an occupant density greater than 100 people per 1,000 ft^2 (6.2.3.9).
- Air- or water-side economizers are needed. There are many exceptions, mainly when dealing with heat recovery.
- Where humidification is needed to maintain humidity above 35°F dewpoint, water-side economizers must be used when economizers are needed. 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

VAV systems are very common for a wide range of applications. They are very useful where there is a high internal heat gain year round and the building can handle large ductwork.

Common applications include:

- Office Buildings
- Schools