Constant Volume with Reheat Systems

System Description

Constant volume with reheat systems provide each zone with a fixed airflow rate at a constant temperature (typically 55°F). The airflow rate is based on the design cooling load for the given zone. The ducting and air handling system are sized to match heat from equipment, lights, exterior and people. Constant volume with reheat systems can heat and cool simultaneously.

At part load conditions, a local reheat coil (typically electric or hot water) raises the air temperature to maintain the space setpoint.

The total building supply air volume is based on the sum of all the zones. Even on a hot design day, not all zones need full cooling at the same time. Because the system cannot vary the supply air volume to each zone, reheat is needed for the zones that do not need full cooling.

Since there is no diversity in supply air volume, significantly more air is circulated than required to meet the cooling load, even at design conditions. This is even greater at part load conditions when compared to VAV. Constant volume with reheat uses more fan power annually than VAV systems.

Cooling the supply air to a design setpoint (typically 55°F) helps ensure the air is properly dehumidified.

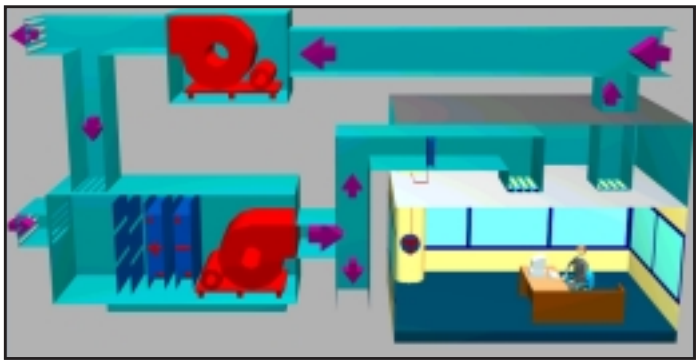
Heating Requirements

Since there is a reheat coil in the ducting that serves each zone, winter heating is usually accomplished by sizing the reheat coil to reheat the air to the space setpoint (typically 75°F) and to provide enough additional heat to offset the heat loss through the walls and roof.

Another method is to heat perimeter zones directly, using electric or hot water baseboards, or radiant panels.

Air Handling Systems

Constant volume systems require some form of centralized air handling units. These can be Vision™ indoor air handlers, vertical self-contained units, or rooftop units. Most can use either air or water side economizers to take advantage of free cooling during mild weather.



When the mechanical cooling is decentralized (such as rooftop or vertical self-contained units), the cooling capacity may be based on the connected load rather than the block cooling load. This can result in significantly more cooling capacity than required to meet the block load.

Air handling systems can be either blow-through or draw-through design. 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). Moisture can be an issue if the air is saturated. 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 about 10% more supply air than blow-through units for the same temperature off the cooling coil. This added supply air increases the duct size requirement and fan operating costs. Moisture is less of an issue as 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, provides a procedure for calculating the minimum outdoor air volume for a system serving multiple zones.

Ventilation air is typically introduced at the air handling unit. Different zones will require different percentages of ventilation air. However, the centralized air handling unit can provide only one outdoor air ratio.

Constant volume with reheat systems provide good air movement, and minimum ventilation air ratios.

System Pros

- Easy to design and install.
- Fixed primary air supply air temperature maintains humidity control in space.
- Air- or water-side economizers can be added easily to the design to minimize mechanical cooling during cooler weather.
- The main air handling systems can accommodate the ventilation air, avoiding dedicated ventilation equipment.
- Relatively easy to change system for tenant work.

System Cons

- Supply air volume cannot be varied. Ducting is oversized and there is a significant fan power penalty.
- Heating and cooling at the same time is not energy efficient.
- Large duct shafts from centralized air handling systems are required.
- A separate distributed heating system is required, adding cost and complexity.
- Rooftop and self-contained systems offer limited cooling diversity among different zones.

Energy Considerations

Since constant volume with reheat systems are simultaneous heating and cooling systems, they are typically not energy efficient. Fan work is also very high since the fan capacity is based on the connected load and there is no variation in air volume at part load. ASHRAE Std 90.1-1999 allows constant volume for specific applications such as health care. 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).
- 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).
- For systems under 20,000 cfm, constant volume fans are limited to 1.2 hp/1,000 cfm. For systems over 20,000 cfm, fans are limited to 1.1. hp/1,000 cfm (6.3.2.1).

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

Constant volume with reheat is an excellent system for healthcare and other specialized applications where air turnover rates exceed the air volume required to meet the cooling load. In specialized applications like healthcare, it is accepted by ASHRAE STD 90.1-1999.

Common applications include:

- Healthcare
- Nursing Homes
- Labs
- Pharmaceutical