Constant Volume-Variable Temperature Systems

System Description

Constant volume-variable temperature systems provide a zone with a fixed airflow rate. The air volume is usually based on the design cooling load for the given zone. The ducting and air handling system are sized to match the heat gain from equipment, lights, exterior, and people.

Air temperature can be varied in the air handling unit to meet the sensible heating or cooling requirement of the zone. One air handling system is required for each zone because there can be only one supply air temperature at any given time.

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, some zone air handling systems will have to supply warmer air to maintain the space setpoint.

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 systems. Constant volume systems use more fan power annually than VAV systems.

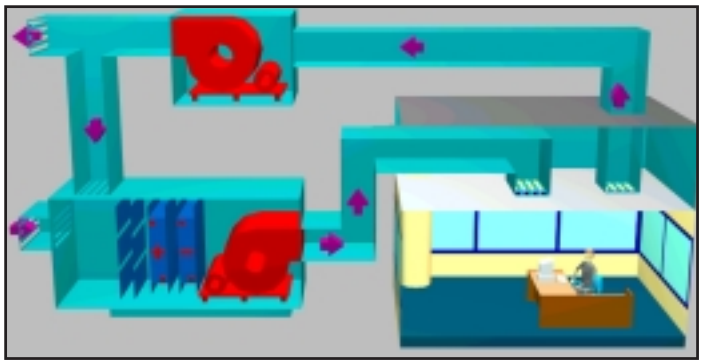
Heating Requirements

The air-handling unit supplies warm air to the space. Another way to heat the space is to use 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 is based on the connected load rather than the block cooling load. This can result in significantly more cooling 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. Saturation 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. Ventilation air for the space can be set at the minimum outdoor air rate because the unit is dedicated to a particular zone.

Dehumidification can be a concern. Since the supply air temperature is modulated to meet the sensible cooling load only, humidity from ventilation air may not be removed, resulting in humid air being distributed throughout the building.

Constant volume-variable temperature systems are good for maintaining the correct amount of outdoor air for each zone.

System Pros

- Easy to design and install
- Dedicated unit per zone offers good temperature control and redundancy.
- 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.
- Varying the supply air temperature does not guarantee dehumidification.
- Many small systems are needed, each requiring access to the zone it serves.
- Rooftop and self-contained systems offer limited cooling diversity among different zones.

Energy Considerations

Constant volume, variable temperature systems use more fan work than VAV systems because they are usually designed for a larger design supply air flow rate, and they cannot modulate the supply air flow rate during part load conditions. 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 ft2 (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 (6.3.3.1).

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-variable temperature systems are typically used in small-to-medium projects of one or two stories. They are also used for air conditioning manufacturing plants.

Common applications include:

- Retail
- Small office buildings
- Manufacturing

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