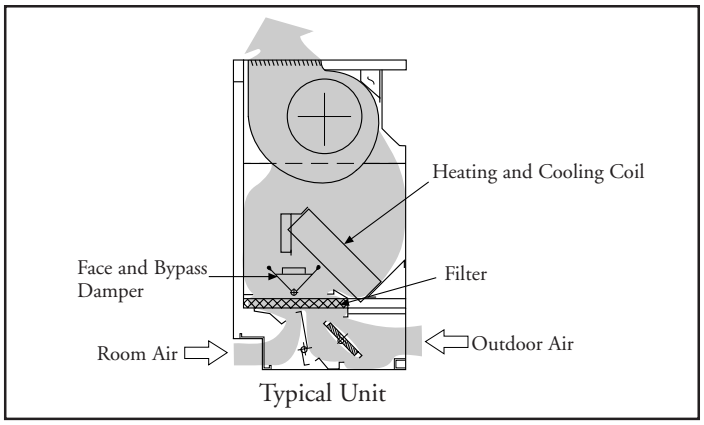
Four-Pipe Unit Ventilators

System Description

Unit ventilators are individual air handling systems located in or near the zone they serve. They have an integral air-side economizer that allows up to 100% free cooling (100% outdoor air) when weather allows, reducing energy consumption. Unit ventilators are typically designed to introduce large amounts (45-50%) of outdoor air directly into the zone at summer and winter design conditions. Their main application is school classrooms. Unit ventilators have institutional-grade construction specifically designed for the classroom environment.



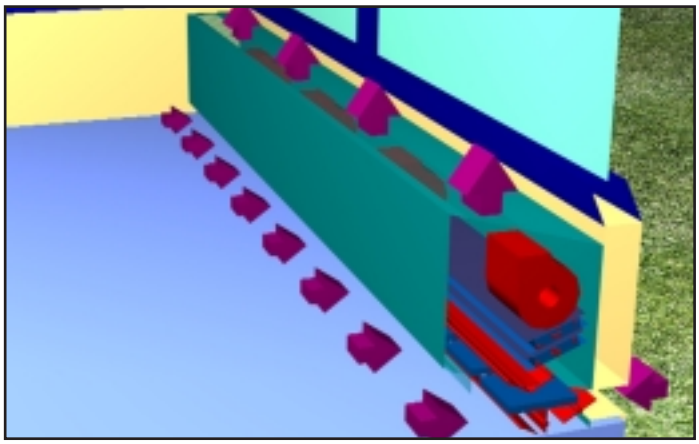
Typical Unit

Four-pipe unit ventilators have hot water (or steam) heating coils and chilled water cooling coils. Having dedicated heating and cooling coils allows one zone to be in heating while another is in cooling. The integral air-side economizer allows free cooling when the weather is appropriate.

The supply air temperature is varied to meet the heating or cooling requirements of the classroom. Unit ventilators typically employ face and bypass control which provide superior dehumidification during cooling and optimum temperature control while reducing the risk of coil freeze ups during heating in cold climates.

Chiller Plants

Any type of chiller system can be used to provide chilled water for unit ventilators. Centralizing the mechanical cooling allows the chiller to be sized for the block load rather than the connected load. This is typically a significant savings in air conditioning capacity.



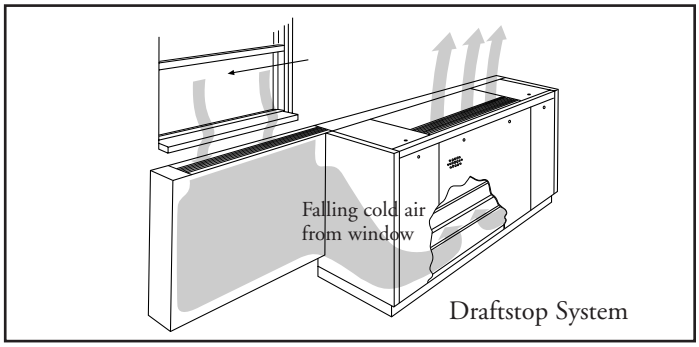
Outdoor air-cooled chillers are typically used to reduce the size of a mechanical equipment room.

With face and bypass control, end-of-cycle valves are used, and constant flow, multiple speed or variable chilled water flow is possible.

Heating Plants

Heating can be provided by either hot water or steam, with hot water being more common. Unit ventilators generally provide sufficient heat to meet the zone heat load.

Draft control



Draftstop System

Down drafts can be generated in classrooms with relatively large windows during prolonged periods of cold outside temperatures. This can be resolved by systems such as DraftStop™ which interrupts falling cold air at the window sill level and returns the air back to the unit ventilator rather than allowing it to spill out on to the zone occupants.

IAQ Considerations

ASHRAE Standard 62.1-1999 provides procedures for calculating ventilation rates to maintain minimum acceptable indoor air quality.

Ventilation air is introduced directly into the zone through the economizer in the unit ventilator, so each zone receives the required ventilation. Ventilation rates can be adjusted by CO_2 Demand Control Ventilation (DCV). CO_2 is an excellent measure of occupancy. With this ASHRAE-accepted control method, energy use is minimized, since only the required amount of outdoor air is introduced while ensuring good indoor air quality. Ventilation is optimized, while providing energy savings versus a fixed ventilation rate. Most systems are on a time clock to avoid unnecessary ventilation during unoccupied hours.

System Pros

- Low capital cost.
- Low operating cost.
- Very energy efficient since there is very little fan work and it can utilize high efficiency air-cooled chillers and condensing boilers.
- Ventilation air (outdoor air) is introduced directly into the zone.
- 100% Outdoor Air (Air Economizer) used to avoid mechanical cooling during cooler weather saving energy.
- CO_2 Demand Control Ventilation easily applied to save energy.
- Decentralized approach allows one unit to be serviced without affecting any other zone.
- Allows one zone in heating, another in cooling.
- Easy to design and control.
- Diversity is applied to chiller sizing.

System Cons

- Units are in occupied space.
- Service may interrupt the occupants.
- Typically require some floor space.
- Access to an exterior wall is needed for ventilation air.
- Humidification is difficult.
- Energy recovery is difficult.

Energy Considerations

Since unit ventilators use very little fan power, they are good candidates for an energy efficient design. 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).
- CO_2 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).
- Energy recovery is required for individual systems with 5,000 cfm plus 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

Unit ventilators are generally used in schools. They can also be used for meeting rooms, nursing homes and other applications with high ventilation rates.

Common applications include:

- Schools
- Meeting Rooms
- Nursing Homes