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5.2.2 Air Distribution Systems

On an annual basis, continuously operating air distribution fans can consume more electricity than chillers or boilers, which run only intermittently. High-efficiency air distribution systems can substantially reduce fan power required by an HVAC system, resulting in dramatic energy savings. Because fan power increases at the square of air speed, delivering a large mass of air at low velocity is a far more efficient design strategy than pushing air through small ducts at high velocity. Supplying only as much air as is needed to condition or ventilate a space through the use of variable-air-volume systems is more efficient than supplying a constant volume of air at all times.

Opportunities

The largest gains in efficiency for air distribution systems are realized in the system design phase during new construction or major retrofits. Modifications to air distribution systems are difficult to make in existing buildings, except during a major renovation.

Technical Information

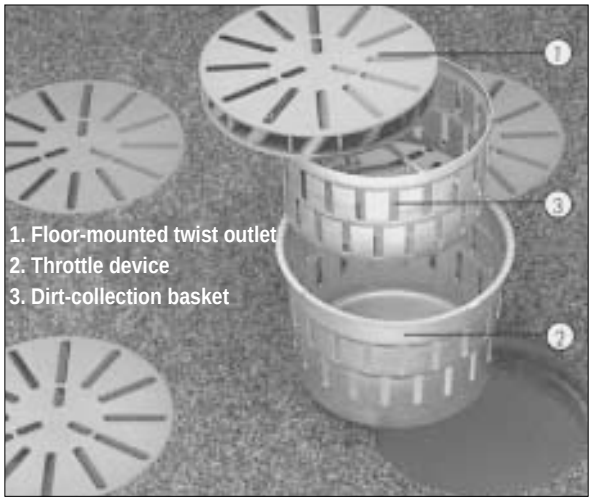
Design options for improving air distribution efficiency include (1) variable-air-volume (VAV) systems, (2) VAV diffusers, (3) low-pressure-drop ducting design, (4) low-face-velocity air handlers, (5) fan sizing and variable-frequency-drive (VFD) motors, and (6) displacement-ventilation systems. These are described below.

Deliver only the volume of air needed for conditioning the actual load. Variable-air-volume systems offer superior energy performance compared with constant-volume systems with dual ducts or terminal reheat that use backward-inclined or airfoil fans. VAV systems are becoming an increasingly standard design practice, yet even greater efficiency gains can be made through careful selection of equipment and system design.

Use local VAV diffusers for individual temperature control. Temperatures across a multiroom zone in a VAV system can vary widely, causing individuals further from the thermostat and VAV box location to be uncomfortable. Local ceiling diffusers ducted from the VAV box to individual rooms can modulate the amount of conditioned air delivered to a space, eliminating the inefficient practice of overheating or overcooling spaces to ensure the comfort of all occupants. VAV diffusers require low duct static pressures—0.25 inches of water column (62 Pa) or less—and thus save on fan energy.

Increase duct size to reduce duct pressure drop and fan speed. Eliminate resistance in the duct system by improving the aerodynamics of the flow paths and avoiding sharp turns in duct routing. Increasing the size of ducting where possible allows reductions in air velocity, which in turn permit reductions in fan speed and yield substantial energy savings. Small increases in duct diameter can yield large pressure drop and fan energy savings, because the pressure drop in ducts is proportional to the inverse of duct diameter to the fifth power.

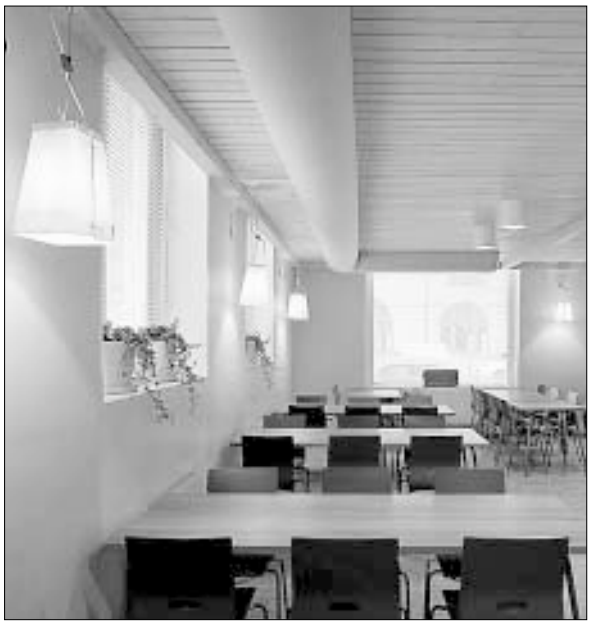
Specify low-face-velocity air handlers—to reduce air velocity across coils. Oversizing the air handler increases the cross-sectional area of the airflow, allowing the delivery of the same required airflow at a slower air speed for only a relatively small loss of floor space. The pressure drop across the coils decreases with the square of the air speed, allowing the use of a smaller fan and smaller VFD, thus reducing the first-costs of those components. Air traveling at a lower velocity remains in contact with cooling coils longer, allowing warmer



Source: Krantz

Designed for use with access flooring systems, these passive air diffusers from Krantz swirl air, causing it to mix very quickly with surrounding air.

$ Facility managers can evaluate the benefits of reducing the size of fan systems in facilities by running EPA's *QuikFan* software. The software is available to Green Lights and ENERGY STAR® Building Partners.



Half-round textile ducts in the Carlsson company's dining room (in Sweden) retain their shape even when not inflated with supply air. Source: KE Fibertec North America

chilled water temperatures. This can yield substantial compounded savings through downsizing of the chilled water plant (as long as all air-handling units in a facility are sized with these design strategies in mind).

Size fans correctly and install VFDs on fan motors. Replace oversized fans with units that match the load. Electronically control the fan motor's speed and torque to continually match fan speed with changing building-load conditions. Electronic control of the fan speed and airflow can replace inefficient mechanical controls, such as inlet vanes or outlet dampers. (See *Section 5.7.2 – Variable-Frequency Drives*.)

Use the displacement method for special facility types. Displacement ventilation systems can largely eliminate the need for ducting by supplying air through a floor plenum and using a ceiling plenum or ceiling ducts as the return. Raised (access) floors providing air delivery are commonly used in Europe and rapidly gaining popularity in the United States. This design strategy is best used in (1) facilities that already include, or can accommodate, low-wall duct mounts or a floor plenum; (2) spaces with high ceilings, in which only a small band of air at the floor level needs to be conditioned for occupant comfort; (3) clean-room or laboratory spaces that require high-volume ventilation or laminar airflow; or (4) facilities in which other benefits of access floors, such as telecommunications wiring needs and high churn rate, are important. Because of the air delivery characteristics, the conditioned supply air does not have to be chilled as much, resulting in additional energy savings.

Be certain that proper ventilation and humidity control is provided by the air distribution system even when heating and cooling loads are low. If fans are set up to respond only to space temperature requirements, space ventilation can fall below acceptable limits during mild weather. This is a very important air quality issue.

Using fabric ducting for exposed applications can help avoid duct cleaning difficulties. Conditioned supply air inflates the ducts and diffuses through the fabric into the occupied space, providing final filtration of the supply air in the process. Textile ducting can be removed and washed in conventional clothes washers at low labor costs, an important savings opportunity for sensitive areas that require frequent cleaning, such as food processing facilities.

References

Variable Air Volume Systems: Maximum Energy Efficiency and Profits (430-R-95-002), U.S. Environmental Protection Agency, 1995; www.epa.gov.

Cler, Gerald, et al., *Commercial Space Cooling and Air Handling Technology Atlas*, E Source, Inc., Boulder, CO, 1997; (303) 440-8500; www.esource.com.