TDV Improves Efficiency and Classroom Environment

The Problem

Many existing school air-conditioning systems are using a conventional mixed-ventilation approach. This method uses more energy than is necessary and often fails to provide the indoor air quality (IAQ), the appropriate acoustic environment, and the comfort levels that produce optimal student and teacher performance.

The Solution

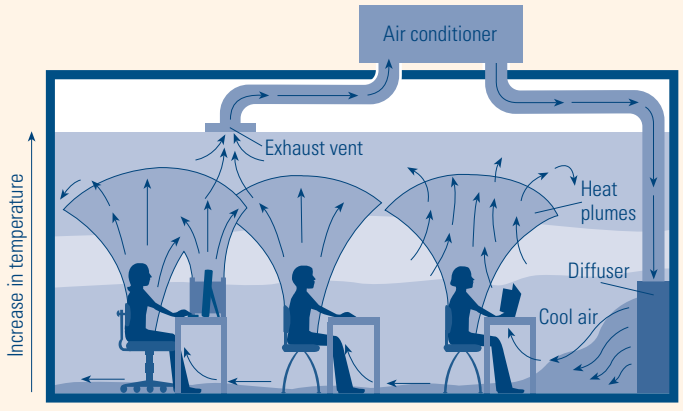
Thermal displacement ventilation (TDV) addresses these problems by delivering cool air directly to the occupants of a space. The fresh air is supplied near the floor at a very low velocity, where it falls toward the floor and spreads across the room (**Figure 1**). As the air picks up heat from occupants and equipment, it rises to the ceiling and is exhausted from the space. Contaminants, including germs from the occupants, are carried up and out of the space instead of being mixed with the room air as they are with conventional ventilation schemes. TDV systems differ from underfloor air distribution systems in that they do not require a raised floor and they supply air at lower velocities.

Features and Benefits

A study of two California schools completed in 2006 by Architectural Energy Corp. of Boulder, Colorado, showed that TDV can provide several benefits at an initial cost comparable to that of many less-effective conventional mixed-ventilation systems that rely on creating fully mixed air in the room.

Figure 1: Classroom TDV airflow patterns

With a thermal displacement ventilation (TDV) system, cool air flows along the bottom of the room, picking up heat from the occupants and rising to the exhaust vent.



Improved IAQ. The rising thermal plumes of a TDV system carry contaminants away from people and toward the ceiling exhaust. Measurements of carbon dioxide levels in the occupied space showed lower concentrations in rooms using TDV than in those using conventional systems. This airflow pattern also inhibits transfer of pollutants from one student to another and between the students and the teacher.

Quieter operation. The low ventilation rate reduces noise from the fan motor compared with conventional cooling systems. Spot measurements of background noise levels in a test classroom using TDV showed a typical range of 40 to 44 decibels (dB) with the fan at maximum speed. In contrast, a typical classroom using a conventional cooling system had noise levels in the 48- to 50-dB range. Lower noise levels mean that teachers are less likely to turn off the ventilation system, which can affect both comfort and air quality.

Improved comfort. Based on surveys completed by teachers in the test classrooms in the study, the steady supply-air temperature was shown to be more comfortable than the temperature variations often experienced with conventional systems.

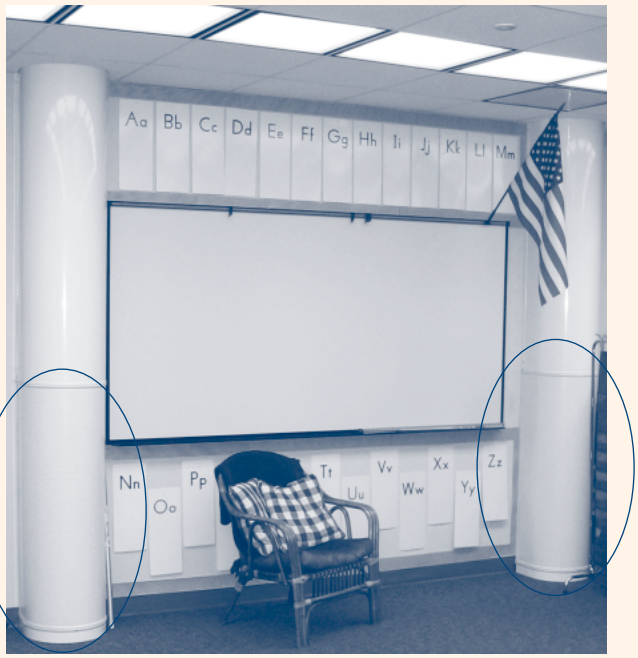
Energy savings. TDV systems use 10 to 40 percent less energy than conventional cooling and ventilation systems in California, depending on climate. This is primarily due to the fact that they supply air at 65° Fahrenheit (F)—approximately 10°F warmer than with a conventional air-conditioning system. Colder air is not necessary because the warm air that rises above the occupied zone of a room is exhausted out of the space instead of being mixed back into it, as is the case with conventional systems. The higher supply-air temperature enables economizers to be used more often and also decreases the load on the air-conditioning system when it does run.

Applications

TDV is best suited for new buildings with 9- to 12-foot ceilings. The study showed that TDV design is relatively straightforward for simple space types such as classrooms, and it has also been successfully used in libraries and gymnasiums (**Figure 2**). However, implementing TDV in spaces with ceilings much higher than 12 feet would require airflow simulations to ensure proper air distribution. The study also found that although TDV is suitable for all of California, buildings in cold mountain climates will need supplemental perimeter heating, which could have a negative impact on

Figure 2: Displacement ventilation diffusers in a classroom

Although the diffusers in this retrofit project from the wall—they're in the bottom of the two white columns—in new construction they can be installed flush with the wall.



TDV's cost-effectiveness. TDV can also be used throughout the U.S. The Southwest offers the greatest potential for energy savings due to its lower humidity and heating loads.

California Codes and Standards

TDV is eligible for credits as a compliance option in the 2008 Title 24 Building Energy Efficiency Standards to be launched beginning in 2009.

What's Next

TDV works best with HVAC equipment that can provide relatively constant 65°F supply air over a range of outdoor temperatures and part-load conditions. Only one manufacturer, Aaon of Tulsa, Oklahoma, produces a packaged rooftop air conditioner—the most commonly used type of HVAC equipment in California K–12 schools—in the 2- to 5-ton range that meets this need. However, Carrier plans to release a unit in the summer of 2008 that is designed to handle TDV needs.

Collaborators

The organizations involved with this project include Architectural Energy Corp., Capistrano Unified and Dry Creek Joint Elementary School Districts, Trane, and Carrier Corp. CTG Energetics of Irvine, California, also contributed to the development of TDV design details for the project. Additional funding for this project was provided by San Diego Gas & Electric Co.

For More Information

Detailed information and reports on this project are available online at www.energy.ca.gov/publications/displayOneReport.php?pubNum=CEC-500-2007-006.

To view Technical Briefs on other topics, visit www.esource.com/public/products/cec_form.asp.

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About PIER

This project was conducted by the California Energy Commission's Public Interest Energy Research (PIER) Program. PIER supports public interest energy research and development that helps improve the quality of life in California by bringing environmentally safe, affordable, and reliable energy services and products to the marketplace.

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