

COMBINATION VRF/Enthalpy Wheel Unit Ventilators FOR SCHOOL RETROFIT

Decentralizing HVAC in self-contained VRF and heat-recovery wheel unit ventilators saves Tennessee school district significant energy costs and provides superior outdoor air IAQ.

BY JOHN PARRIS FRANTZ

Images courtesy of Four Seasons Inc.

En route to providing an HVAC retrofit solution for four Union County Tennessee schools, engineers and contractors have designed a state-of-the-art unit ventilator that might revolutionize future educational facility retrofits nationwide. What might be the first of its kind, Union County Public Schools (UCPS) is using a combination variable-refrigerant flow (VRF) and an outdoor air energy-recovery wheel compactly packaged in what appears externally as a conventional 36 (H) x 104 (L) x 30 (D)-in. fan-coil-style hydronic unit ventilator commonly used in classrooms for decades.

The project was designed by Jonathan Yeager, P.E., eSolutions (Knoxville, TN), a manufacturer's representative with design/build engineering capabilities and a focus on emerging energy-efficient HVAC products. Mechanical Contractor Randy Guignard, President of Four Seasons Inc., (Knoxville, TN), designed the unit ventilators and is now manufacturing the system in-house under the Revolutionaire brand. The system replaced the original aged steam radiators and window air-conditioners in classrooms at Horace Maynard Middle School, Sharps Chapel elementary, Maynardville Elementary and Big Ridge Elementary School. Also assisting with the project design was Semco LLC (Columbia, MO), which supplied heat-recovery enthalpy wheels custom-manufactured for the project, and Mitsubishi Electric Heating & Cooling (Suwanee, GA), the VRF equipment supplier.

The retrofit is superior in indoor air comfort and more than doubles the 8-SEER rating of the old system and promises significant annual energy savings and payback. The project's results are supported with an energy-performance contract by Johnson Controls Inc. (Milwaukee, WI), which also manufactures the Metasys building-management system (BMS) that controls buildings throughout the district.

Custom design

Guignard and Yeager's original VRF unit ventilator-style retrofit system was designed for the Nashville Metro Public School system, but without energy recovery because existing enthalpy wheels were too large to fit the encasement. The design's sec-



» Union County Tennessee Schools are the first to retrofit energy inefficient, noisy unit ventilators with VRF systems combining an enthalpy wheel for energy recovery. Some of the individuals that helped make that possible are Jonathan Yeager, P.E., of manufacturer's representative eSolutions (foreground) and Randy Guignard, President of mechanical contractor Four Seasons Inc. (background).

ond generation progressed to energy recovery when Guignard and Yeager worked with SEMCO to custom-build a universal (aluminum) wheel cassette (UWC) featuring a 21-in. diameter x 3 3/4-in. deep wheel using molecular sieve desiccant material. The horizontally mounted UWC-21 wheel reduced the peak cooling capacity by 1 1/2 tons per unit for a total project reduction of 37.5 tons vs. a VRF-only unit and increases efficiency by approximately 15%. Adding the enthalpy wheel helped the retrofit easily surpass the requirements for the ASHRAE 90.1 Standard "Energy Standard for Buildings—Except Low-Rise Residential Buildings."

Aluminum wheels with molecular sieve desiccant were chosen for their higher latent capacity vs. plastic wheels with silica gel desiccant. Furthermore, aluminum wheel/molecular sieve wheels do not cross contaminate between supply and exhaust air, have lower static pressure drops and so require less fan energy, have longer lifecycles and need less maintenance than plastic wheels, according to Yeager.

“We wanted the highest performance that an aluminum wheel offers, plus the tighter woven flutes of plastic wheels attract more debris and act as a filter that requires more maintenance,” said Yeager.

Generally, the UCPS project uses 24-ton ground-mounted Mitsubishi CITY MULTI series VRF condensers supplying approximately eight classroom unit ventilator evaporator coils. Each room is overseen by the JCI control system and occupancy sensors, which cut unit ventilation operation by more than 50% during unoccupied periods, according to Yeager. Each unit sports quiet-running fans from ebm-pabst (Farmington, CN).

Each classroom unit supplies approximately 350 cfm–400 cfm of outdoor air, which is slightly more than needed in order to provide outdoor air to hallways and other common areas drawn by bathroom exhaust fans. Large spaces, such as cafeteria or gyms at the four schools, either have multiple VRF/energy wheel ventilators or more conventional equipment, such as the HMMS auditorium’s 15-ton, 6,000-cfm rooftop HVAC manufactured by York, a division of JCI (Norman, OK).

Final decision

The final choice of VRF/energy-recovery wheel unit ventilators was a compromise between a costly/high-efficiency or an inexpensive/less-efficient solution. The most efficient solution—geothermal with water-source heat pump-based unit ventilators—was too costly at an estimated \$2 million, much of which would be applied toward bore fields for each of the four schools. A less efficient and inexpensive option, costing an estimated \$300,000, was heat-pump ventilators for each classroom, however this option did

not include updating the school to current ASHRAE 62.1 outdoor air or ASHRAE 90.1 energy-sustainability standards.

“Our solution’s (VRF/energy-wheel recovery) cost was a compromise between the two alternatives, plus it provided outstanding outdoor air and significant energy sustainability,” said Yeager.

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» Prior to installing unit ventilators with VRF and energy-recovery wheel technology, the schools were using window units and radiators (inset). The decision was a compromise between a costly/high-efficiency and an inexpensive/less-efficient solution to bring the school up to speed in ASHRAE standards.



Conventional VRF—rooftop condensers feeding ceiling cassette and wall evaporators plus separate dedicated outdoor air systems (DOAS) with ductwork running through unfinished ceilings—was not practical, according to Yeager.

United Services (Powell, TN) was the installing contractor for the auditorium sheet-metal ductwork as well as all the project’s piping and HVAC systems installation. The previous steam boiler system was also removed and replaced with electric boilers for domestic hot water.

The trend in HVAC for decades has been centralization, such as rooftop units supplying an entire building or central plants supplying one facility or an entire campus. The first-of-its-kind HVAC innovations at UCPS could be spear-

heading a new trend toward decentralization in education settings. Self-contained VRF/enthalpy-wheel units can provide a classroom retrofit solution for long-term savings from heat recovery, moderate first-cost equipment outlays, lower installation/labor costs and less building envelope disruption associated with ductless systems, plus state-of-the-art indoor air quality, according to Yeager. Guignard said the next generation design will incorporate a slimmer enclosure and lower-db, higher-efficiency fans.

“Unit ventilators combining VRF with enthalpy wheels to decentralize outdoor air are going to revolutionize the education facility HVAC market, as many decades-old, less efficient conventional unit ventilator systems reach their lifecycle ends,” said Yeager. “We’ve already presented this design and its energy-saving results to other school districts and it has been very well-received.”

References

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⤴ A view of the state-of-the-art solution installed in one of the school classrooms.

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