SCHOOL DEHUMIDIFICATION

Three ways to dehumidify schools for increased IAQ, productivity and attendance.

The Robert D. Campbell Junior High School in Kentucky was retrofitted with active chilled beams and a 5,000-cfm DOAS and uses controllable chilled beam pump modules, or CCBPMs.

BY LEN KOBYLUS

Images courtesy of SEMCO LLC.

There are a variety of methods to incorporate dehumidification into school facilities for energy savings, indoor air quality (IAQ) and general improvement to student and faculty health. While IAQ and energy savings are well-known benefits, many contractors and school officials might be surprised to learn dehumidification can also have a positive effect on the attendance records, health and well-being of students and teachers.

A guest speaker school superintendent raised a few eyebrows at the 2015 Summer Conference of the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) in Atlanta, GA when he claimed his new school's HVAC system had raised attendance figures.

"The first year our new George Rogers Clark (GRC) High School opened, we achieved the highest student attendance figures in our school district's history, and I attribute that mostly to its (unprecedented) indoor air quality," said Paul Christy, Superintendent, Clark County Public Schools, Winchester, KY, who addressed a seminar room packed with engineers and contractors.

Several dual-desiccant wheel dedicated outdoor air systems (DOAS) were a major component of Clark County's new $60-million, 300,000-sq.-ft high school that also included an 80-well geothermal field and chilled beams in the HVAC design.

Dehumidification has come to the forefront of HVAC design the last 20 years, mainly due to the increased outdoor air (OA) requirement in commercial building codes and the exorbitant energy costs associated with dehumidifying it. Dehumidification, as it relates to the health of occupants, might still be considered experimental in school construction, but it has gained a wider acceptance in healthcare, as that industry continues an uphill battle with health-acquired infections (HAI), which affected 722,000 U.S. patients and killed 75,000 during their hospitalizations in 2011, according to an HAI Prevalence Survey conducted by the Center for Disease Control (CDC).

Maintaining a certain relative humidity (RH) in hospitals creates a less conducive atmosphere for airborne biological contaminants to develop. Therefore, it was no surprise that an active desiccant system won the 2016 AHR Innovation Awards IAQ category winner, a competition profiling the most promising new HVAC products appearing at the annual AHR Expo. The unit was developed specifically for dehumidifying surgery suites to inhibit HAI growth via lower dew-point temperatures and 100% OA supply humidity levels, but without the significant energy inefficiency trade-offs of conventional OA systems that skyrocket facility operational costs.

School dehumidification options

Schools should also look at dehumidification as a way to promote better occupant health. There are several methods to choose from, however, two of the most popular methods are using a DOAS or an energy-recovery ventilator (ERV).

Another Kentucky school, the Robert D. Campbell Junior High School was retrofitted in 2015 from circa-1970 unit ventilators to 212 active chilled beams and a 5,000-cfm DOAS, but with a new twist. Chilled beams and DOAS are not new, but the 200,000-sq.-ft retrofitted school is the world's first known building to use smart, plug-and-play controllable chilled-beam pump modules (CCBPM). The CCBPMs helped save hundreds of thousands of dollars in capital equipment and labor/installation costs, because they reuse the 43-year-old building's original two-pipe infrastructure for the chilled beams. The CCBPM combines chilled-beam indoor air comfort temperature with DOAS optimal humidity control and energy efficiency.

Campbell's HVAC retrofit design provides pinpoint tempered conditions within a 1°F tolerance, regardless of the season, because its control is based on outdoor dew point, not temperature. If the dew point is less than or equal to 45°F, the space latent load is satisfied by DOAS ventilation air, which is distributed through each chilled beam and controlled via its respective CCBPM. When the dew point surpasses 45°F, the school's existing chiller is needed to maintain space conditions. Thus the school's dehumidification is accomplished with DOAS air distribution through the chilled

« The CCBPM can supply up to 10 chilled beams. In a CCBPM zone, warmer chilled beam water is returned to the CCBPM, which mixes it with cooler water from the building's main chilled water loop. The result is zoned pinpoint temperature control.

beams. Because chilled beams have only a 6-in.-diameter take-off for OA, OA ductwork dimensions are significantly smaller, which saves in remodeling costs for a ductless building that was not designed with ceiling space to accommodate large ductwork trunk lines.

The chilled-beam/DOAS combination also saves $33,000 annually vs. the school's former unit ventilator system. The energy savings will lower capital dollars spent on the project by $500,000, which is guaranteed by a performance contract with the Lexington, KY branch of Indianapolis, IN-based, Performance Services Inc. (PSI), an integrated design and delivery engineering contractor that led the project.

A CCBPM, which includes a powered integrated direct digital controller (ddc), chilled- and hot-water connections,

>> Ceiling-hung chilled beams replaced unit ventilators that lacked dehumidification and energy recovery. CCBPMs saved the project hundreds of thousands of dollars because it allowed the reuse of nearly all the building's existing two-pipe system to supply 212 chilled beams.

valves, variable-speed electronically commutated (EC) motor pumps and smart sensors, is superior in temperature and humidity control to the original unit ventilator design, especially during season changes. The plug-and-play CCBPMs eliminate the guesswork associated with chilled-beam system specification, installation, balancing and commissioning. As with most two-pipe designs, the many wildly fluctuating temperatures and humidity of spring and fall days resulted previously with uncomfortable indoor temperatures, because of the extensively long periods required to switch from heating to cooling modes.

Unit ventilators with dehumidification?

Four schools in rural Union County Tennessee were recently outfitted with a totally different concept of dehumidification. Randy Guignard, President of mechanical contractor Four Seasons, and Jonathan Yeager, P.E., a manufacturer's representative, eSolutions, designed a unit ventilator system combining variable-refrigerant flow (VRF) and desiccant wheels for energy recovery and moisture reduction. It might be the first use of VRF and desiccant-wheel heat recovery in a unit ventilator design.

While it appears as a two-pipe unit ventilator supplied by a central plant that is common in tens of thousands of North American school buildings, it incorporates a 21-in.-diamter by 3 3/4-in.-deep molecular sieve desiccant wheel custom made to fit the enclosure. The wheel reduces the peak cooling capacity by 1 1/2-tons per unit and increases efficiency by 15%. (See the complete case study related to this project on pg. 30 in this issue of *RSES Journal*).

Dehumidifying schools with ERVs

Payback for an ERV ranges from less than one year in the southeast to approximately three years for other portions of the country. Payback also depends on whether the facility is operating 24/7 or limited to daily work hours.

When replacing a rooftop installed prior to today's more stringent OA requirements, some contractors oversize the replacement unit to compensate for the larger humidity load of additional OA. However, this ultimately affects indoor air comfort by overcooling the space, short-cycling and ultimately creating other problems, such as high indoor humidity that cannot be removed because the system satisfies the setpoint temperature too quickly and does not run long enough for dehumidifying to comfortable levels.

Therefore, ERVs are also a logical choice for adding dehumidification to schools. The three most popular methods of ERV dehumidification are:

1. Add a stand-alone ERV or a bolted-on version to an existing conventional rooftop DX rooftop HVAC system;
2. Replace the rooftop with a smaller model and add an ERV that is stand-alone or bolted onto the new rooftop HVAC system; and
3. Supplant the rooftop with a self-contained ERV that includes a cooling and/or heating coil modules for total HVAC control with dehumidification.

In the first method, there are literally thousands of schools across North America that can benefit in cost savings and air comfort by adding an ERV. Conventional air-conditioning systems typically have a 0.8 sensible heat ratio, which means the A/C coil's output is 80% sensible cooling and 20% latent capacity. With a large amount of ventilation humidity on a cooling-demand day, there is no standard rooftop HVAC system on the market today that can handle the load of an additional latent requirement.

In the second method, a 17.5-ton rooftop system would need a 27-ton drop-in replacement in order to supply 6,000-cfm of 55°F air to a space with a 50% OA load. Due to the low cfm per ton created in the 27-ton example, the unit would be starved for air and would not be able to accomplish the intended air-conditioning and dehumidification tasks. Instead, an ERV combined with the 17.5-ton replacement could adequately dehumidify the OA to 50%, which means the replacement can better resemble the original equipment's capacity, electrical loads and weight. A larger rooftop replacement's weight might also surpass roof-support capacity.

Adding to the incentive for replacement is the current R-22 refrigerant phaseout. The Environmental Protection Agency (EPA) continues to phase out R-22, which is driving up its price. Losing R-22 refrigerant to a leaking coil—a scenario that typically happens at least once, if not multiple times, during air-conditioning coil lifecycles—could cost a building owner thousands of dollars in refrigerant replacement costs and labor, plus it does not guarantee it will not happen repeatedly. A proactive replacement with a rooftop using newer environmentally friendly refrigerants could head off an expensive repair, not to mention building downtime. Older units are also notorious for running less efficient as they age.

The third method is not considered often enough by engineers and contractors. In some regions of the country where temperature and humidity are moderate, an ERV option added to a cooling and heating coil might supplant the need for a traditional rooftop altogether. For example, an ERV can reduce an OA of 95°F db/78°F wb to 81°F db/67°F wb, which calculates to

50% RH. Adding the right size cooling coil can easily drop the air coming off the ERV wheel to the desired temperature.

Another advantage of an ERV with coil module options is single source responsibility. The ERV manufacturer cannot blame the rooftop manufacturer and vice-versa for poor indoor air comfort conditions.

Desiccant vs. mechanical DX dehumidification is also a choice. Desiccants using materials such as molecular sieves typically adsorb moisture and transfer it through exhaust air in the cooling season. It can also bring it back into the supply air during the drier heating season if humidity is needed. Molecular sieve materials are not susceptible to contaminant adsorption because the smaller pore size only allows the transfer of the water vapor. This makes them a better choice for sensitive environments, such as healthcare and educational facilities. The disadvantage of mechanical DX dehumidification coils is they condense air-stream moisture that accumulates and creates a wet nourishing environment for biological contaminants.

Finally, dehumidification saves energy costs. There is also logical science to support the aforementioned claim that school attendance figures can increase with better IAQ, of which dehumidification plays a significant role. Fresh, dehumidified OA boosts student well-being, productivity and attendance, according to studies, such as the ASHRAE document, "Optimizing IAQ, Humidity Control, and Energy Efficiency in School Environments Through the Application of Desiccant-based Total Energy Recovery Systems," by John C. Fischer.

Dehumidification might also curb the common practice of reducing rooftop system OA ratios to save operational costs, either due to high utility bills or clogged air filters that are not replaced by undermanned or ill-trained school maintenance departments. Another practice is completely shutting down recirculation during off hours, which results in poor IAQ during morning hours of occupancy due to the slow ramp-up of the rooftop system. Either way, these practices can result in biological contaminant and volatile organic compound (VOC) buildups, which can detrimentally affect occupied spaces. With some type of dehumidification reducing operational costs of the air-conditioning system, combined with training, maintenance departments will be less likely to alter OA ratios.

There are many ways to add an ERV. Most manufacturers offer selection software that is very easy to use and calculate the unit's proper sizing and capacity by geographical region. Outfitting the dehumidification of schools should be at the top of every contractor's marketing list. With the proper sales presentation, contractors can gain design/build business while simultaneously giving the taxpayer healthier schools.

Len Kobylus is the OEM Sales Manager at SEMCO LLC (Columbia, MO), a Fläkt Woods Company, specializing in energy-recovery equipment, chilled beams, spiral metal ductwork and HVAC acoustical products. Kobylus has 28 years' experience in HVACR that also includes companies such as Trane Co. and York International, as well as fan and ERV companies. For more information, email len.kobylus@flaktwoods.com or visit www.semcohvac.com.