Ultimate Control in K-12 Schools

Solving a Humidity Problem in South Carolina

When a South Carolina high school added a new wing, it also gained a moisture problem.

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Solving a Humidity Problem

When North Augusta High School in South Carolina opened a new foreign language wing in 1992, school administrators discovered that while they had solved a space problem, they had created a moisture problem.

Teachers, 1,600 enrolled students, and school officials all welcomed the new wing when it opened. The latest expansion added 11,840 sq ft, bringing the school's total square footage to 181,414. The new wing houses 10 classrooms, an assistant principal's office, and a hallway.

Built with 144,000 sq ft in 1969, the school, which sets near the town of North Augusta just across the Savannah River from Augusta, Ga, was expanded twice before -- facilities were added in 1975 and 1985 due to increased enrollment. After the 1992 expansion, however, mysterious moisture-related problems arose, according to Rusty Krewson, buildings and grounds supervisor at the school.

"Wooden desks would swell so bad with moisture, their drawers had to be planed down to operate smoothly," said Krewson.

Mildew grew on carpets and textbooks. Teachers complained of moisture-related illnesses and brought notes from doctors. Ceiling tiles warped, and tape wouldn't stick to walls.

The problems confounded school officials. Moisture hadn't posed a problem in either the original school building or the two previous additions. They couldn't figure out where it came from -- or how to get rid of it.

Students walk along North Augusta High School's new foreign language wing, which had a severe moisture problem five years after it was built.

Diagnosing the Problem

After consulting officials and engineers, it was realized the moisture problems were related to indoor air quality.

The new wing was the first area of the school designed to meet a section of South Carolina's building code, which specifies minimum ventilation requirements for acceptable IAQ. Ventilation systems in the new wing were bringing in moist outside air at higher rates than in other areas of the school.

The HVAC system for the new building made use of the school's existing boiler and chiller for heating and cooling by means of a two-pipe system. Each room had a 4-ton unit ventilator with chilled and hot-water coils and a thermostat. Valves modulated hot and cold water for sensible heating and cooling, and dampers modulated outdoor air flowing past the coils for ventilation.

The unit ventilators supplied outside air at 450 CFM minimum, to 1,600 CFM at 100% economizer mode, with the dampers controlled by enthalpy sensors that compared inside and outdoor conditions. But the units had no means of humidity control.

To quantify the new building's humidity problem and establish a baseline, Krewson's maintenance staff conducted a series of air samplings throughout old and new areas of the school.

Taking samples around the clock, a hygrometer measured moisture content and a dehumidifier measured the amount of water it removed from the air. The dehumidifier's wheel graph chart plotted readings taken with and without students in classrooms, and with outdoor air dampers in the new wing open and closed. Humidity ranged from the high 60s to 72%.

South Carolina has incorporated ASHRAE Standard 62-89 for IAQ ventilation into its School Facilities Planning & Construction Guide, issued by the South Carolina Department of Education. For education buildings, the standard recommends 15 CFM per student and 60% or less relative humidity.

Obviously, the ventilation system in the school's new wing didn't meet the standard, at least from a humidity standpoint.

Call for Help

The school hired an engineering firm, Buford Goff & Associates (BGA) in Columbia, SC, to design a modified system to correct the problem.

BGA was already working on other projects for Aiken County Public Schools and had designed dehumidification systems to solve humidity problems in other South Carolina schools.

Dan Reider, manager of mechanical systems at BGA, says their choices were limited by the fact that the building already had an HVAC system in place, so they couldn't start with a clean sheet of paper. Nonetheless, BGA engineers identified and researched several alternative systems. Early in the design process, they deliberated between using individual space dehumidifiers or installing a central dehumidification system. BGA selected a centralized outdoor air system for several reasons.

According to the firm, such systems can control humidity more precisely and with less-frequent cycling than individual space units, which depend more on dehumidification with reheat. BGA also believes central systems permit the use of various heating sources as well as various cooling coils, such as DX, chilled water, and desiccant.

In the end, the company said, less maintenance is required with central systems because one large unit contains fewer mechanical components such as compressors, fans, and filters, than a multitude of in-room units. And, a central system allows for easier verification that proper volumes of outside air are supplied to the facility.

BGA then looked at the variations of central outdoor air systems, including ones that used desiccant wheels and heat pipe heat exchangers. They finally decided on the "Wringer" system (manufactured by Munters, Natural Bridge Station, VA).

The system uses a cooling coil to remove moisture in conjunction with a plate-type, counter-flow heat exchanger. According to the manufacturer, a DX coil cools the incoming outdoor air to 45°F dew-point, and then the heat exchanger reheats the cold, dry air leaving the dehumidification coil. The manufacturer said the heat exchanger also precools the incoming air, decreasing the tonnage required by the DX coil by about 30% compared with traditional systems.

According to BGA, such a system allows full humidity control of the space by delivering the required level of outdoor air with the moisture level controlled and at a neutral temperature, so it doesn't add to the heating or cooling load.

Saving Energy

According to BGA, the "free" reheat afforded by the heat exchanger reduces energy consumption. (The heat exchanger has an efficiency of about 72%, said the manufacturer.) And unlike in-room dehumidifiers, the new system dehumidifies outdoor air before it gets to the space, said BGA.

The dehumidification system works in conjunction with standard heating and cooling components in an HVAC system. While heating and air conditioning systems concentrate on sensible cooling, the new system handles latent cooling or moisture removal. With the unit ventilators already in place in the classrooms to handle the sensible load, the new system complements the existing system and allows for separately controllable temperature and humidity set-points, according to BGA.

To custom design the system for the application, Reider worked with Keith Dunnavant, a sales engineer at Munters' factory, and Greg Prose of Hoffman & Hoffman, the regional sales representative in Columbia. Reider used 95°F drybulb and 79°F wetbulb for summer outdoor air, in conjunction with 50% to 60% RH for inside air. Winter conditions were 15°F outdoors and 72°F indoors.

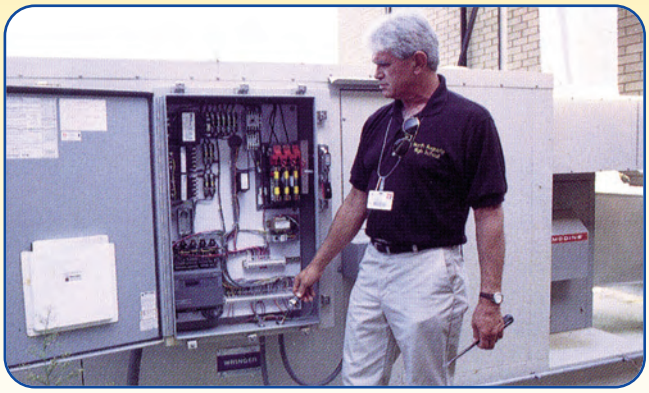
The result was a system capable of delivering 2,200 CFM driven by a 5-hp motor. A DX coil dehumidifies outdoor air using a piped air-cooled condensing unit. The unit is mounted on a concrete slab outside the school building.

An indirect-fired gas heater, rated at 160,000 MBH, mounts integrally to the unit and heats outdoor air to a neutral 72°F in colder weather. According to BGA, this prevents dumping cold air into the space and chilling occupants sitting near the vent.

Reider particularly likes the furnace arrangement, saying an integral factory-mounted, UL-listed furnace wasn't available from other manufacturers considered.

"As an advantage of the new system, we could get the condenser, the heater, and the air handler all mounted on a single skid, prepiped and prewired," says Reider. "We had to do this project in a short time frame over the summer, and this allowed us to speed the job up tremendously.

The installing contractor, Scurry Mechanical Contractors of Saluda, SC, installed ductwork in the ceiling starting in July, allowing the company to concentrate on outside work in September, after students had returned. All they had to do then was connect controls, electricity, and natural gas to the new system.



Rusty Krewson, buildings and grounds supervisor for the North Augusta High School, examines the control panel on the dehumidification unit.

Working with BAS

The Wringer uses Direct Digital Control (DDC), involving what Dunnavant calls "a sophisticated feed-forward control loop." This provides flexibility in sensing parameters, and allows the design engineer or building owner to select different criteria for controlling the system, he said.

According to Dunnavant, sensors measure drybulb temperature, dewpoint, and RH of inside and outdoor air. For inside monitoring, the system works off temperature and humidity sensors located in the assistant principal's office; outdoor sensors are located on the new unit. According to Dunnavant, conditions sensed dictate the number of compressor stages energized for dehumidification cooling.

Conditions can be monitored and adjusted from several locations through a building automation system. The new system controls are linked to a control panel at the Aiken County District Maintenance Office. From here, maintenance personnel keep tabs on several schools in the district, programming on-off temperature settings, receiving alerts for out-of-parameter conditions, and plotting temperature, humidity, and dewpoint trends. Maintenance personnel can often take corrective action without making a trip to the school.

At the dehumidifier control panel, technicians can program system parameters using a laptop computer, allowing school officials to override the district office and reset the unit after a power failure. To assist with starting the system and turning it over to the school, Munters sent a technician to the site to operate the system.

Although the building automation system permits starting and stopping of the new system, it was determined after installation that the unit should run continuously. Besides controlling temperature and humidity when students occupy the building, this maintains positive pressure in the classrooms with the building unoccupied. Reider said 2,200 CFM works well for maintaining positive pressure.

The hot - and chilled-water coils in the classroom unit ventilators are still used for heating and cooling, but Krewson says the fresh air intakes on the units have been closed so they don't compete with the new system.

All Systems Go

From all reports, the dehumidification system appears to have solved the moisture problem at North Augusta High School.

“We went back to the school six or eight times after it was installed, and they've not seen any humidity problems whatsoever,” says Reider.

Perhaps Allen Mayberry, maintenance operations supervisor for the Aiken County School District, summed up the $60,000 upgrade project best.

“We fought that moisture every way we could, and this thing took care of the problem.”

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