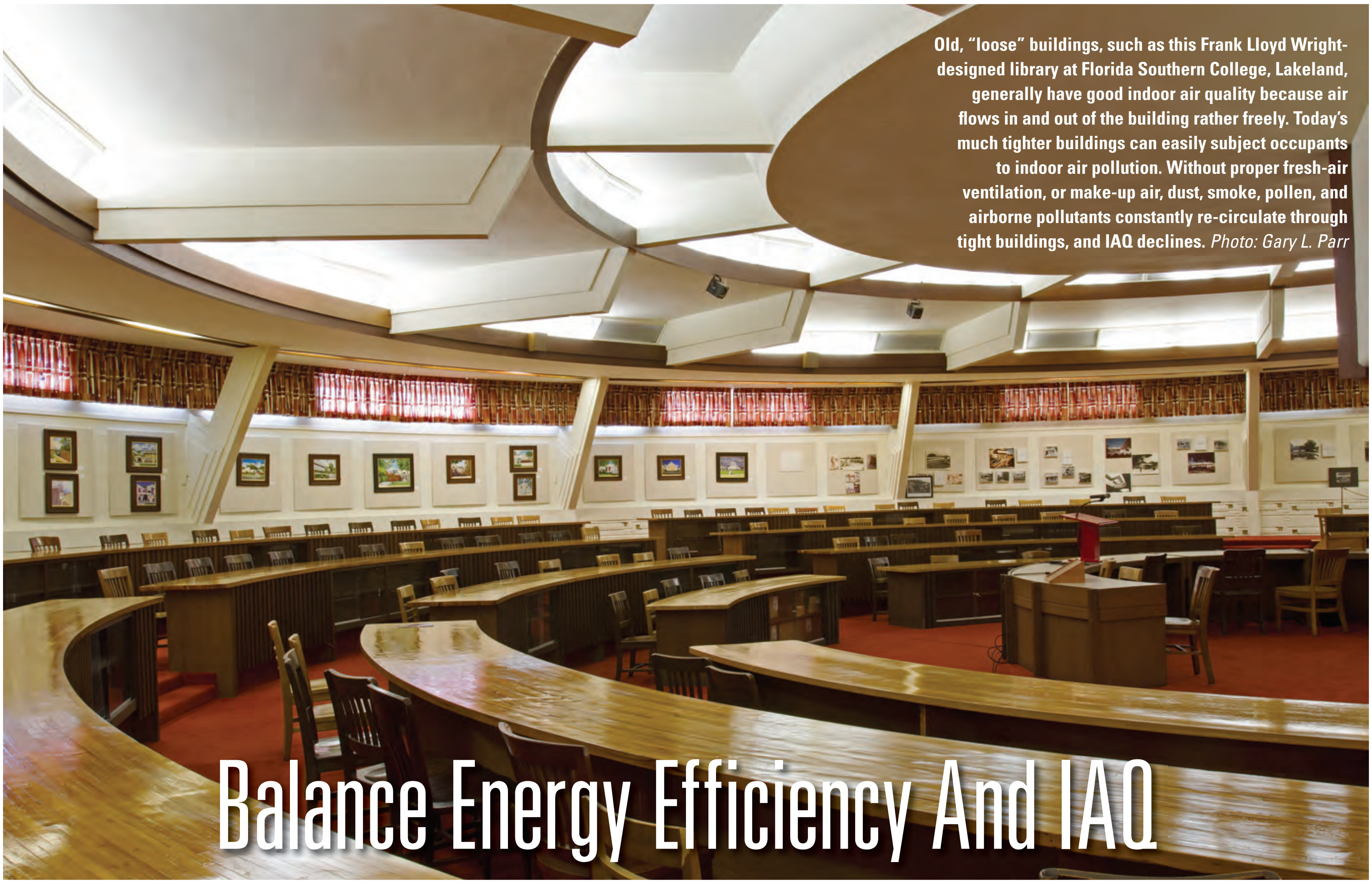


Old, "loose" buildings, such as this Frank Lloyd Wright-designed library at Florida Southern College, Lakeland, generally have good indoor air quality because air flows in and out of the building rather freely. Today's much tighter buildings can easily subject occupants to indoor air pollution. Without proper fresh-air ventilation, or make-up air, dust, smoke, pollen, and airborne pollutants constantly re-circulate through tight buildings, and IAQ declines. *Photo: Gary L. Parr*

Balance Energy Efficiency And IAQ

Tightly sealed structures may be efficient, but indoor air quality shouldn't suffer to achieve that efficiency.

John Vastyn, Common Ground

In the push to make structures tight and energy efficient, some buildings were built like hermetically sealed containers. Preventing infiltration and exfiltration and reducing ventilation saves energy, of course, but the downside is occupants are captive to carpet, paint, and adhesive off-gassing, in addition to other building pollutants that influence indoor air quality (IAQ). According to the Environmental Protection Agency (EPA), Washington, indoor pollution sources that release gases or particles into the air are the primary cause of indoor air quality problems in commercial facilities.

Negative pressure affects tight buildings, such as hospitals, clinics, and biomedical facilities, because exhaust fans push inside air outside, and not enough fresh air is provided to replace the exhausted air. Without proper fresh-air ventilation, or make-up air, dust, smoke, pollen, and airborne pollutants constantly re-circulate through tight buildings. It's also possible that combustion appliances may back-draft due to negative pressure, spilling harmful emissions back into enclosed spaces as humidity accumulates and IAQ declines.

"There is a variety of commercial equipment and appliances that forcibly expel inside air," said Mike Schires, senior product manager for Racine, WI-based Modine Manufacturing Co.'s Commercial Products Group. "Laboratories and kitchens have exhaust hoods. Industrial buildings have exhaust for welding stations, paint-spray booths, chemical-wash tanks, and machinery heat rejection." (See sidebar, *Engineering Firm Invests In IAQ*).

"If you do nothing to bring air back into the building, there will be problems with IAQ," he said. "The building will pull air from anywhere it can. And this is what creates a negative pressure condition. Air from outside comes in through cracks in walls and windows or even around ostensibly 'sealed' junctures at walls, roof lines, and wall penetrations."

"This is uncontrolled infiltration and it causes drafty, uncomfortable conditions, as well as increased dust and dirt in the building," Schires continued.

The problem doesn't end there, however. "If there is equipment with natural draft venting, [negative pressure may cause] air to be drawn through the stack rather than venting out," Schires added. Harmful or lethal contaminants, such as carbon monoxide, are brought inside, or air could be drawn in from other parts of the building and, with it, unwanted odors, chemicals, and humidity.

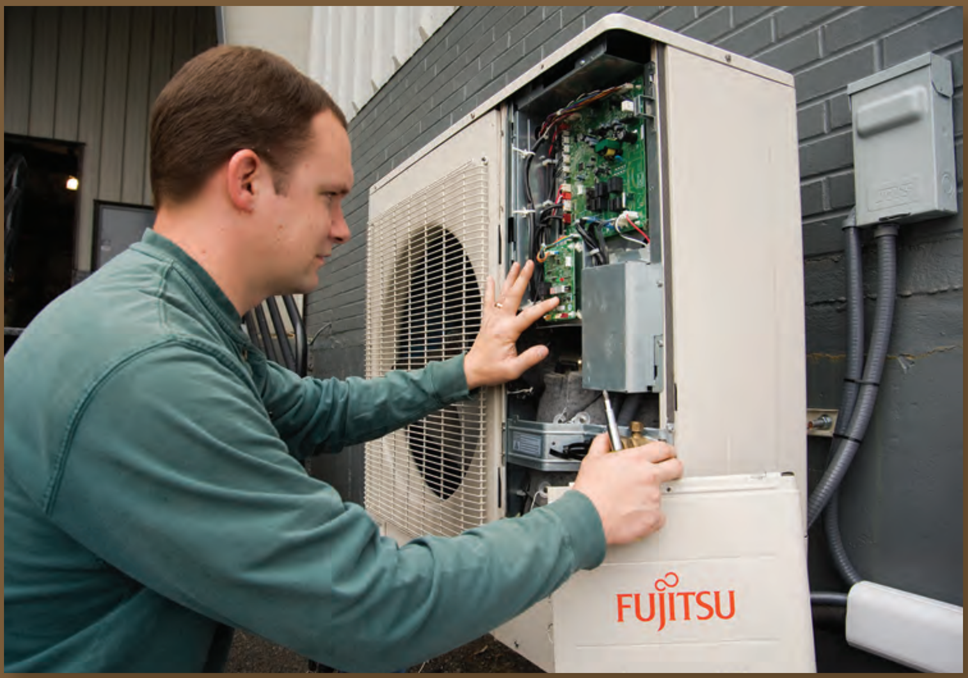
One indicator of negative pressure that may be obvious to building occupants is that doors can be hard to open. To correct the problem, make-up air must replace, or make up, what is being exhausted.

Loosen up

It seems contradictory that a building made airtight to save energy should be loosened up to become healthy, but that is the reality.

Ventilation air is normally occupant-demand driven. Take, for example, a high school gym where children are playing and practicing. They exhale CO_2, water vapor, and perhaps a familiar oh-so-human smell. It doesn't take long and the need for ventilation becomes essential. "At this stage, maybe not a lot of ventilation is needed because there are only 10 to 20 kids and a coach," said Schires, "but when the big game comes, conditions change in a hurry.

"The room's population is a game-changer," Schires explained. "If nothing is done, that



A Fujitsu high-efficiency condensing unit is installed at Cornerstone Church, California, MD. The Fujitsu mini-split systems were paired with a 15-ton Modine Atherion unit, offering ERV-conditioned fresh air, AC, and heating capabilities.

One-Two Punch Lowers Energy Use

Every once in a while two separate technologies come together so perfectly they dramatically improve the other's performance and application possibilities. Such is the case with a commercial rooftop energy-recovery ventilator (ERV) and a ductless, mini-split, heat-pump system. The benefactors of the union are the 350 members at the Cornerstone Presbyterian Church, California, MD.

The design phase for a new wing of the church was a six-month process. Several contractors, reps, and engineers offered different views about how to condition the single story, 14,000-sq.-ft. addition, which mainly comprised classroom space.

After careful consideration, church members settled on a hybrid system that would tap an ERV to supply make-up air to mini-splits equipped with make-up-air collars.

The idea of using an ERV to supply outside air to ductless mini-splits was Frank Simmons' brainchild. Simmons, owner of Simmons Heating and Air Conditioning in Hollywood, MD, knew he'd need to pull some expertise on board to design and refine the system. Although he had the tools and the know-how to tackle the project, Simmons knew the hybrid system he was hoping to install was, for the most part, uncharted waters.

Simmons took his idea to Ken Herne, at manufacturer's rep firm Harry Eklof & Associates Inc. Located in Landover, MD, the company has 10 years of experience with ductless heat-pump applications.

Herne and Simmons proposed using Fairfield, NJ-based Fujitsu's HFI (hybrid flex inverter) ductless heat pumps with ceiling cassette evaporators equipped with outside-air collars. The quandary came when it was time to select the ERV. At the beginning of the design phase, there weren't any obvious best options. No single ERV manufacturer seemed to have exactly what they were looking for.

In the time it took for the project to come together on paper, a new player came onto the field; one that seemed as if it had been custom tailored to the needs of Cornerstone Church.

The "secret weapon" of choice, to work in concert with the mini-split systems, was a 15-ton Atherion from Modine Manufacturing Co., Racine, WI, offering ERV, AC, and heating capabilities in a compact rooftop package.

At Cornerstone, the packaged ventilation system supplies ERV-conditioned air to the collars on the cassette units, in turn reducing the required capacity of the heat pumps. The unit's ERV is rated at 65% "effectiveness" a term used to describe how effectively an ERV transfers energy from the exhaust air to the supply air.

A technician prepares refrigerant lines for a ceiling cassette in the addition at Cornerstone Church, California, MD.

"Add the ERV's efficiency to the rated efficiency of the HFI system and you've got a combination that's real tough to beat," says Herne. High SEER and EER ratings and the advantage of modulating operation combine optimally with the capabilities of the Atherion.

"We won twice with the mini-split approach, considering that when the split systems were sized, the availability of supplemental capacity from the Atherion was taken into consideration," said Herne. "We reduced the ductless system load by 35%."

"Should the heating or cooling capacity of the heat pumps be exceeded, we capitalize on the modulating ability of the packaged ventilation system's heating and cooling elements, delivering only the capacity needed to meet the demand, and no more," added Herne.

Equipped with 20-kW backup heat and CO_2 sensors, Modine's system will also run whenever the building's air needs to be exchanged.

"We were glad to hear that mingling the ductless heat-pump units with the packaged air handler meant less total installed capacity," said Scott Hoffman, head of the church's building committee. "But the ductless units are also great because of their ability to condition the church on a room-to-room basis. That way we aren't heating or cooling any rooms that aren't in use."

Engineering Firm Invests In IAQ

At Rite Engineering in Franksville, WI, they tap, ream, mill, drill, and bore, to aerospace specifications, everything from plastic to titanium. To justify the expense of more than a million dollars for a single machine, it has to perform up to expectations. When an entire 11,000-sq.-ft. machine shop is full of those machines, time is money. Rick Hennig, owner of Rite Engineering, knows the drill.

"The machines cost a lot of money, and they make a lot of money but only if they're running spot-on," he said. "They produce more than precision components, though. They make lots of heat, and the lubricant smokes."

Over the past several years, demand for Rite Engineering products has increased, so Hennig added more machines to his production floor. On the hottest days of summer, his workers could only get several hours of work done in the morning. By noon, they had to leave for the day; both workers and precision equipment were unable to tolerate the stifling heat and unhealthy air inside the shop; million-dollar machines sat idle.

Hennig needed a solution that would handle the whole shop. He contacted nearby Modine Manufacturing Co., Racine, to see if they could offer a cost-effective means of improving conditions at his facility. Robert Fritchen, brand sales manager of unitary products at Modine, had an answer: Modine's commercial packaged-ventilation system, a 100% dedicated outside-air system with an integrated energy-recovery ventilation (ERV) module. A 15-ton, 180,000-BTU Atherion unit was installed on a frame just above ground level outside Rite Engineering's main building.

"The day after they commissioned the unit, the first full day of use, the air quality and temperature inside the shop were infinitely better. It was hard to believe because we'd become accustomed to such poor air quality," said Hennig. "There was no haze hanging around the ceiling, and it almost felt like we were working outside."

It wasn't long before new orders meant more machinery. Floor space in the shop approached capacity. The comfort level workers had grown accustomed to tapered off with the addition of each new machine.

This time, Henning expanded the facility by 6,000 sq. ft. and ordered a new 30-ton Atherion rooftop system. Together, the mechanical systems keep the air clean and properly conditioned.

Modine's Atherion commercial packaged-ventilation system, a 100% dedicated outside-air system with an integrated energy-recovery ventilation (ERV) module, was installed at Rite Engineering, Franksville, WI, to improve temperature and air quality for the machine shop.

space will get very hot, humid, smelly, and uncomfortable in a hurry. The ventilation rate needs to be increased significantly; we measure that air exchange in cubic feet per minute (cfm)."

The bigger the crowd, the more cfm required. These are important considerations when designing interior spaces with unique needs, such as condominiums, hotels, hospitals, and schools. Perhaps, to a lesser extent, the same needs apply to churches, theaters, clinical offices, and retail stores. (See sidebar, *One-Two Punch Lowers Energy Use.*)

Outside air

Mechanical equipment for make-up air and ventilation is similar because both systems are bringing in large volumes of outside air, according to Schires. Ventilation equipment typically also includes a power-exhaust feature because, in addition to bringing in large volumes of fresh air, there also is a need to get rid of bad air within the facility and keep it balanced.

"The advantage with ventilation equipment is that, with the exhaust function performed by the same equipment, it gives building designers and owners the opportunity to incorporate energy-recovery technology," Schires stated. "This can help to reduce equipment size and energy use."

The key with either type of equipment is to properly condition the air being brought in. For instance, in Minneapolis, ambient temperatures can range between –20 F and 100 F during a 12-month period. That's a 120 F variance, including vast changes in humidity levels. The equipment tasked to introduce fresh air must also heat, cool, and dehumidify. Indoor-air targets for good IAQ are between 30% and 60% relative humidity (RH); 50% is a typical target.

Schires offered this example: "It's 95 F outside, with 40% relative humidity, and the building owner specifies a need for 75 F in the space. All that the building-systems designer needs to do is to cool that air by 20 F to get to 75 F, right? Well, as you probably know, it's not quite that easy."

"Let's say that air delivery comes in at roughly 75% RH," he continued. "That's very bad air from an IAQ standpoint and must be dehumidified." According to Schires, most packaged rooftop HVAC equipment can dehumidify only about 20%, or maybe as much as 30% outside-air exchange when ambient humidity is high.

The answer to dealing with large swings in temperature and humidity is through equipment that modulates control of heating, cooling, and dehumidification, said Schires.

Making structures more energy efficient is a worthy goal, but simply tightening the building envelope often brings with it unintended consequences, such as increased indoor pollution and uncomfortable, unhappy occupants. Careful attention to make-up and ventilation air is the solution that will result in a structure that balances efficiency with comfort and productivity. cbp

John Vastyan is president of Common Ground, a trade communications firm based in Manheim, PA, that specializes in the hydronics, radiant-heat, plumbing and mechanical, geothermal, and HVAC industries.