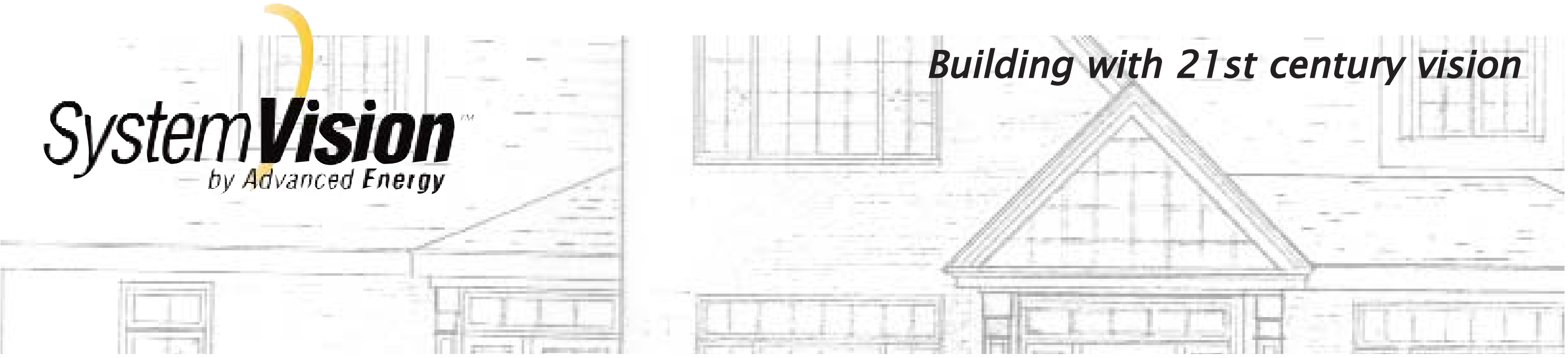

Use and Misuse of Energy Recovery Ventilators (ERVs) in Hot, Humid Climates
by Bruce Davis

As building science professionals have known for some time, an effective ventilation strategy is an absolute requirement for all homes. Mechanical ventilators exchange air inside the home with fresh air from the outside. This helps to reduce indoor pollution levels, and greatly increases the comfort level inside the home.

Many ventilation designs are including Energy Recovery Ventilators (ERVs) to improve the system efficiency. Besides providing controlled ventilation, ERVs are able to filter, humidify, dehumidify, heat, or cool the incoming fresh air. The most popular design of ERVs utilizes a desiccant wheel to remove both heat and a significant amount of moisture from the incoming air, which reduces the load on the air-conditioning system. But while ventilators and ERVs can add tremendously to the comfort and efficiency of a home, they must be installed correctly.

Bruce Davis is a building science specialist with Advanced Energy of Raleigh, North Carolina. While Davis is an unabashed advocate of mechanical ventilation in general – and of energy recovery ventilators (ERVs) in particular – he cautions homeowners, builders, and contractors against the potential pitfalls of installing ERVs in hot, humid climates.

ERVs and HRVs (heat recovery ventilators) were both initially designed and used in the northern part of the country, using cold-climate ventilation strategies. ERVs are now beginning to see wider use in the Southeast. But ventilation strategies that work well in cold areas can backfire when used in a hot, humid climate.

As Davis explains, in a southern climate, most of the ERVs job during the summer months is removing moisture from the incoming air. "In Raleigh during the cooling season, your major load is going to be the moisture in the incoming air stream," says Davis. "To achieve space-neutral conditions during the cooling season (75°F (24°C) and 50% relative humidity), a base-case home with 80 cfm of ventilation air would require 5,760,000 BTUs to remove moisture from the incoming air stream, but only 864,000 BTUs to cool it." An incredible 87% of the energy used to condition the air inside the home would be spent on dehumidification alone!

Ventilation: Not a Question of "If"

To most building scientists – and a growing number of residential designers and builders – mechanical ventilation is not longer a question of If. To ensure homeowner safety and comfort, ventilation has moved into the Must and How lists.

"Knowing what we do about indoor air quality and moisture problems, it just shouldn't be a question a longer," states Davis. "People don't consider whether or not their new house needs a roof. If they were more knowledgeable about air quality, they wouldn't question the need for a ventilation system either." Unfortunately, is seems that many homeowners still feel a much greater need for a big-screen TV or other convenience, rather than for fresh air to breathe.

The answer, of course, lies in educating homeowners, builders, and HVAC contractors about proper ventilation. As so often is the case, knowledge brings power. Following education, contractors need proper training in the installation and operation of ERVs, and in particular, instructions on proper venting strategies for the ventilators. Lastly, people need to be shown that ERVs and other mechanical ventilators are affordable to operate. In Davis' own home, the costs of using his ERV amounted to less than $10 month, providing a safe level of 0.65 air changes per hour all year round. That equated to 167 kWh of electricity per month to run the ERV motor, and to operate the heat pump to condition the fresh air drawn in by the ERV. For a safe, comfortable home, $10 per month is a small price to pay.

Field Study

Davis and his fellow building scientists studied the operation and installation of ERVs and other mechanical ventilation systems in eight homes in the Raleigh area. All of the systems were newly installed – and all of the systems had problems.

Beyond simple equipment failures, the study clearly showed that the contractors who installed the ERV systems did not understand the critical importance of controlling the latent load (moisture) present in the incoming air. In three of the systems investigated, the ERV actually added moisture to the air stream, and raised the relative humidity (RH) of the air inside the houses. And as explain earlier, removing moisture from the air is the ERV's top priority in the summer months.

A Little Close to Home

Ironically, the first system included in the study was Davis' own. Testing revealed that the low-speed airflow on Davis' system was 162 cfm — more than twice the 80 cfm rating listed by the manufacturer. The discrepancy in airflow meant that the ERV (a Honeywell ER200) wasn't delivering the 79% Total Recovery Efficiency (TRE) promised, since the TRE rating was designated at an optimum airflow of 108 cfm.

Davis' airflow problem was corrected by adjusting the system control potentiometer. The incident piqued his scientific curiosity though, and prompted him to investigate other ERVs in the area. Sure enough, two additional ER200s turned up with the same control board problem. The control unit, manufactured for Honeywell by AirXChange, has since been discontinued for reasons unrelated to the control board flaw.

Turning the ERV into a Humidifier

Two other homes in the study illustrated how improper installation can not only reduce ERV performance, but can actually worsen the environment inside the home. In Case Study #4, the homeowner complained about high humidity problems Investigation revealed that the installation contractor had chosen an ERV with a low TRE rating – that is, a limited ability to transfer moisture. Rather than install a separate duct system for the ventilation air, the contractor had connected the exhaust duct from the ERV into the return duct for the heat pump. This design relied on the heat pump's blower and the existing ductwork to distribute fresh air throughout the home. The system was set to run continually on low speed, and switch to high speed using timers mounted in the bathrooms. Exhaust air was drawn in from the bathrooms and a laundry room.

Initial testing showed an indoor relative humidity (RH) of 61%. However, the RH rose as high as 72% during certain periods in the test data. Correlating the high-humidity peaks with the home's heat pump operation cycles, showed that the RH inside the house rose and fell with the cycling of the heat pump compressor. Each time the heat pump compressor cycled off, water would drip off the coils and puddle in the catchpan below. But since the heat pump blower was interlocked for continual operation with the ERV, the blower continued to run. As the incoming air was drawn across the water on the heat pump's coil and catchpan, it picked up a considerable amount of moisture. Testing the fresh air entering the heat pump revealed a humidity of 77.6 grains of moisture. But after passing through the heat pump (without the compressor running), the air entering the house contained 95 grains of moisture.

As if the system didn't already have enough moisture to deal with, the location of the exhaust grills in the bathroom added to the problem. Whenever someone in the house took a shower, moisture-laden air from the bathroom would be drawn into the distribution system. With the way the ERV ducting was designed, the ERV itself would then transfer this moisture over to the fresh air coming into the house.

The homeowner in Case Study #5 experienced similar installation problems and consequences. The house was equipped with a vanEE 1000 Duo (TRE rating « 61%). Once again, the contractor tied the fresh air supply into the existing air conditioning duct and used the AC fan (wired for continual operation) to supply the house with fresh air. This effectively transformed the ERV into a very unwanted humidifier. Testing of the home found that the indoor RH remained in near 70%, cycling over a 6% range with the operation of the heat pump compressor.

In Case Study #5, the ERV had a respectable TRE rating. Unfortunately, the unit's capacity was seriously compromised by an unbalanced air flow between the inlet and exhaust. The unit's TRE rating was based on a balanced airflow of 120 cfm. With the ERV ducting installed as it was, the volume of incoming air was 40% larger than the volume of outgoing air. And while the incoming air had a moisture content of 20 to 26 grains, the ERV could only remove 7 to 10 grains because of the unbalanced airflow.

Other Common Problems

The eight case studies turned up a collection of problems found in many of the homes. Most of these were the result of installation errors or shortcuts that could have been avoided through proper training and job quality. The most common mistakes are listed below:

- Controls installed incorrectly.
- Controls not connected to ERV.
- Controls inaccessibly located
- System running only when high-speed bathroom timers activated.
- Humidity sensor installed to set the unit to high speed during the summer.
- Humidistat set to turn the ERV ventilator off during rainy periods, in order to reduce incoming moisture load.
- Supply and exhaust ducts both connected to intake collars on the ERV, so that all of the air was exhausted. This mistake turned the balanced-flow system into an exhaust-only system, blowing 330 cfm out of the house.
- Air filter small or inadequate.
- No grease filter on kitchen exhaust port.
- Outdoor intake and exhaust hoods located together in a deep alcove under a low deck. This design allows exhausted air to immediately reenter the home, defeating the entire purpose of the ERV system.

The case studies discussed in this article are described in more detail in Mechanical Ventilation in Houses in the Southeast; Doing the Right Thing Not-Quite-Right, a paper presented at the ACEEE's 1998 Summer Study on Energy Efficiency in Buildings. Copies of the article are available from Advanced Energy's website: www.advancedenergy.org/.

Recommended Practices

Separate Ducting is a Must

In hot, humid climates, the best installation is also the simplest: a completely separate duct system for the ERV. By not tying the ERV system back into the existing ductwork, the builder and homeowner can avoid all the problems associated with system controllers, airflow, and pressure differences.

ERVs are generally well-built and well-designed pieces of equipment. But, as Davis puts it: "It's the installation that's shooting us in the foot." By separating the ERV inlet and exhaust from the rest of the home's ductwork, many of the moisture problems noted in the study could have been avoided.

Isolate Bathrooms

As the survey research has shown, connecting the bathroom vent into the ERV return or the HVAC ducting returns warm, moist air back into the house – exactly what you don't want. Davis recommends that bathrooms be equipped with independent exhaust fans and vents. Whenever possible, the ducting design for the home should avoid locating return grills in the bathrooms, in an effort to reduce moisture problems.

ERV Checklist

During the ERV study, one thing was very apparent: neither the homeowners, the builders, or the installation contractors had a very clear idea of what to expect from their ERVs. While most contractors are interested in doing the best job possible, their efforts may be futile without several key pieces of information. In response, Davis has developed a checklist to help homeowners and contractors alike understand the requirements for a quality ERV installation.

- Select an ERV with a good TRE rating, and a recognized recovery performance rating for summer conditions.
- Select a quiet system.
- ERV ventilation system ducting should be completely separate from the HVAC system.
- Use separate ducting for kitchen and bathroom exhaust fan.
- Install multiple supply vents and a central exhaust.
- Design system for dedicated volume and continuous operation.
- Use plain controls that consumers can easily access and understand.
- Provide a full range of airflows.
- Filter the system on both the intake and exhaust sides (pleated filters work best).
- Separate the intake and exhaust terminals outside the house to prevent air stream crossover.
- Seal and insulate all ductwork, and test for leakage.
- Contractor should measure ERV airstreams to ensure airflow through the ERV is balanced.
- Contractor and customer should confirm that all controls work as intended.
- Contractor should document all performance tests in writing and explain them to the customer.
- System should include a maintenance plan with a schedule for changing the ERV filters, cleaning the outside air intake screen, and removing and cleaning the core and wheels once a year.