Measuring the Real Cost of Ventilation

With the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) putting the final touches on its new residential ventilation standard (ASHRAE 62.2), a lot of designers and builders are wondering how they're going to provide new homes with fresh air at an affordable price.

The measured results from a number of new houses built in Vernon Hills, Illinois, show how adequate fresh air ventilation can be supplied for less than $175 in installed equipment costs and less than $30 in annual operating costs. Armin Rudd, a building scientist and inventor with Building Science Corp. (Westford, Massachusetts), did the research under the sponsorship of the US Department of Energy's Building America Program.

The homes in question were built by Town and Country Homes (Westchester, Illinois) as part of a new 191-unit development called Centennial Crossing (see *EDU*, August 1998). During construction, these large, upscale homes were equipped with a central fan-integrated supply ventilation system. As shown in Figure 9, the system is designed so that the air handler pulls fresh air into the return side of the furnace through a six-inch insulated outside air duct. An adjustable AirCycler control assures that ventilation air will be drawn into the house and distributed even when there's no thermostat demand for heating or cooling. It does this by using smart logic to operate the fan when the fan has been inactive for a programmable period of time. (See *EDU*, January 2000, for more details on the control.)

Because of concerns in the industry about the operating costs of mechanical ventilation systems, Rudd measured the amount of time that the air handler was running exclusively to provide ventilation. (The rest of the time, ventilation air was brought in and distributed as a "free" byproduct of either heating or cooling.)

In the house located on lot 22, the 350-watt blower consumed just $21.76 in electricity to meet the home's ventilation needs over the roughly 10-month test period (see Table 3). These costs, calculated at 8 cents per kilowatt-hour, are for fan energy only and do not include the extra energy that was required to condition incoming fresh air.

The AirCycler in this house was set on a 19% duty cycle — that is, 25 minutes off and 6 minutes on — to provide each occupant with 10 cfm of fresh air per minute via mechanical ventilation. Additional fresh air was supplied incidentally by infiltration through the envelope. "Based on tracer gas testing, we assumed 0.1 air changes per hour as our background infiltration number," Rudd explains. (Editor's note: The mechanical ventilation requirement in ASHRAE 62.2 now calls for 7.5 cfm per person, plus 1 cfm for each 100 ft² of floor space, with an infiltration credit set at 2 cfm per 100 ft². (See *EDU*, January 2001.)

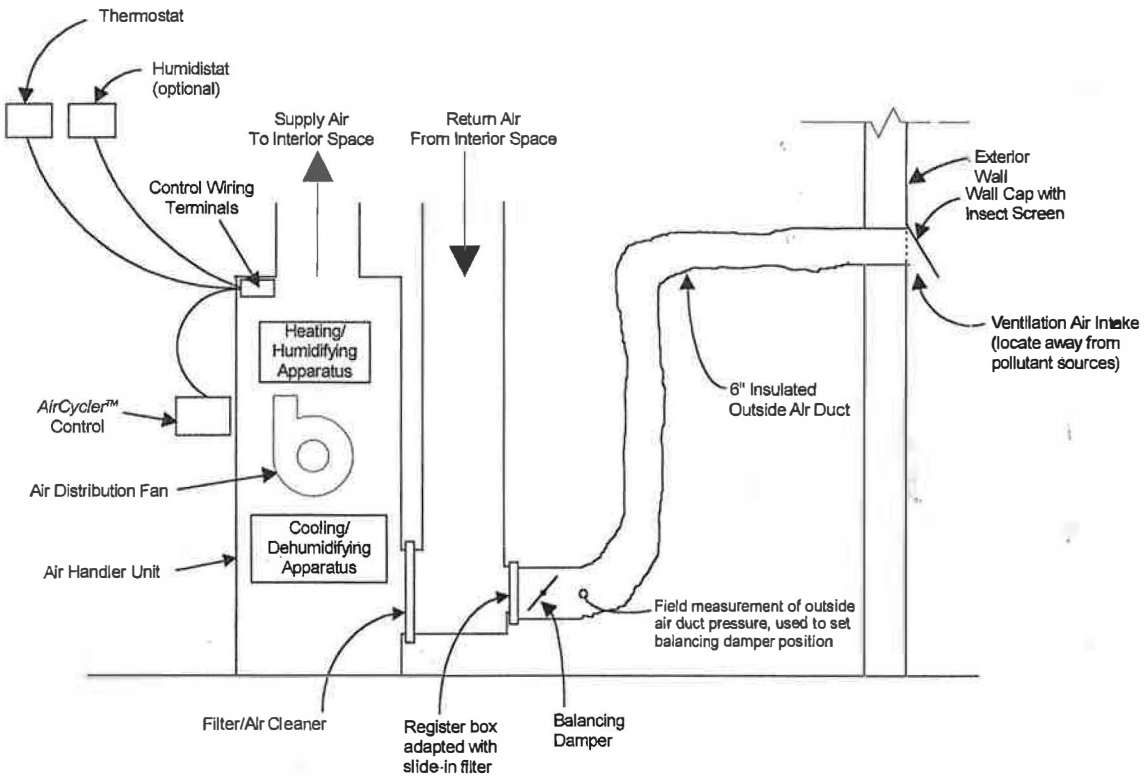

Figure 9 — Central fan-integrated supply ventilation as installed at Centennial Crossing (Vernon Hills, Illinois).

Table 3 — Monitored Runtime and Monthly Electrical Costs at 19% Duty Cycle (Centennial Crossing/Lot 22)

	Cool ON (%)	Heat ON (%)	Fan Recycling Vent ON (%)	Fan Recycling Cost ($)
Apr (27-30)	0	12	12	0.24
May	1	2	15	3.06
Jun	7	1	10	2.05
Jul	10	0	12	2.58
Aug	10	0	13	2.72
Sep	5	0	15	2.96
Oct	0	4	15	3.07
Nov	0	13	10	1.99
Dec	0	20	6	1.31
Jan	0	31	3	0.60
Feb	0	23	5	0.95
Mar (1-9)	0	25	4	0.23

Notes: Fan recycling control set for 25 min OFF, 6 min ON (19% duty cycle)

As shown in the Table 3, the highest fan electrical costs occurred in the shoulder months of May and October ($3.06 and $3.07, respectively). "The controller really shined during those mild months when there was very little heating or cooling demand," Rudd says. "The reason the fan electricity costs are highest during those months is because the fan is running almost exclusively to draw in fresh air and distribute it. Of course, the occupants also get the benefits of improved comfort due to the whole-house recirculation."

Rudd tells *EDU* that the AirCycler performed accurately over the test period, with less than a 5% difference between the control setting and the measured duty cycle. Installation costs of the complete system ranged from $125 to $175 per house.

Some builders have expressed concern that this type of ventilation system would pressurize the house and drive warm moist air into the walls during the winter, presenting the danger of condensation and moisture problems. But Rudd says his measurements indicate that the house is only pressurized by 0.5-1 pascals and that there's no more than a 3 pascal pressure difference anywhere in the house. "You don't have to be really concerned about driving humidity into the walls at those pressure levels," he concludes. "Besides, our controlled mechanical ventilation system, along with the use of kitchen and bath ventilation, keep the indoor humidity level in check."

For hot, humid climates in the South, Rudd recommends that the system be complemented with a dehumidifier, not because the ventilation system demands it, but to control humidity year-round independent of thermostat demand for cooling.

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READERS FORUM

In Defense of Programmable Thermostats

Dear Editor,

We read with great interest the article entitled "An Unexpected Setback for Programmable Thermostats" in the November issue of *EDU*. The Energy Coordinating Agency (ECA), a Philadelphia-based nonprofit corporation, has had just the opposite experience with programmable thermostats. As with any energy conservation device that requires the active participation of the occupants, programmable thermostats require thorough education. Without it, they will certainly cause confusion, frustration, and will fail to yield their potential savings. However, with education, programmable thermostats can be an extremely effective conservation treatment.

Through the low-income conservation program that we administer for the Philadelphia Gas Works (PGW), ECA has installed over 8,000 programmable thermostats in the last four years. The evaluated savings from these years find that the thermostat is the single most cost-effective measure in the program.

Michael Blasnik, the independent evaluator for PGW, statistically disaggregated savings into the program's major measures of roof insulation, thermostats, air sealing, and "other" (which includes savings from education and low-cost measures). The savings for thermostats were 111 ccf [100 cubic feet] per year or 8% of total gas usage. At an installed cost of $85 each, the thermostats were the most cost-effective treatment by far, yielding a benefit cost ratio of 8:30.

In our experience, it is absolutely necessary to provide very clear education to customers initially and to be willing to answer questions and reeducate as needed. We find that customers who have the thermostat installed in the spring or summer inevitably forget the initial education and need a refresher in the fall when the heating system kicks back on. We have become proficient at providing this refresher over the phone, limiting the number of in-person visits required. We also send written reminders to customers to help refresh their memories and leave a sticker with our name and phone number right inside the thermostat case.

Programmable thermostats require careful education, but, as our independent evaluations show, are well worth the effort.

Liz Robinson
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