RESEARCH AND IDEAS

Does A Cathedralized Attic Need A Supply Register?

If a home lacks a basement, builders are tempted to install ductwork in the attic. In spite of the well-known drawbacks to such systems, attic ductwork remains very common in areas of the country where slab foundations prevail.

For several years, the US Department of Energy's Building America program has been promoting the use of sealed, conditioned attics — also known as cathedralized attics — as a relatively easy way to bring attic ductwork within a home's conditioned envelope. To create a cathedralized attic, insulation (usually spray polyurethane foam) is installed on the underside of the roof sheathing and against the gable-wall sheathing.

Is A Supply Air Register Necessary?

Once an attic is cathedralized, builders face a question: Should the attic be directly conditioned — that is, equipped with supply and return registers — or indirectly conditioned — that is, heated and cooled by conduction through the attic floor and incidental losses from the air distribution system in the attic? The answer, according to a recent Florida study, is that there is no compelling reason to directly condition a cathedralized attic — at least in a hot, humid climate.

John Broniek, a senior research project manager with IBACOS in Pittsburgh, Pennsylvania, conducted the study in Orlando, Florida. Reporting on the research, Broniek presented a paper, "A Cathedralized Attic in a Hot Humid Climate: Is it Worth Conditioning?," on December 5, 2007, at the Buildings 10 conference in Clearwater Beach, Florida. Broniek's research was funded by the Building America program.

A Big Florida House

Broniek collected his data at a single house, a 6,506-square-foot show home (the "New American Home") built in 2005 for the 2006 International Builders' Show. Though unusually large, the Orlando home was energy-efficient, with a HERS 91 rating (using the old HERS methodology). Blower-door testing showed 2.6 air changes per hour @ 50 Pascals (equivalent to about 0.23 natural air changes per hour). The home was unoccupied during the research.

Broniek chose to limit his research to the 1,190-square-foot master bedroom suite, a section of the house with its own attic and a dedicated HVAC system. The attic was cathedralized by spraying R-20 open-cell spray polyurethane foam on the underside of the roof sheathing and at the gable ends.

The master bedroom suite's air handler and associated ductwork (R-4 insulated flex ducts) were located in the attic. Duct testing showed 6% leakage — "less than the Building America project target of 10%."

Cooling and heating were provided by an air-source heat pump rated for 3 tons of cooling. In spite of the advice provided by IBACOS engineers, the HVAC contractor installed a system that was "oversized by 55% for total cooling and by 73% for heating compared to ACCA Manual J calculations."

Sensors and Motorized Dampers

The attic was equipped with supply and return ducts; according to Manual J, the attic requires 100 cfm. Commissioning tests showed that the actual supply air flow was 104 cfm. All ducts serving the attic space were equipped with motorized dampers that allowed the researchers to control whether the attic was directly conditioned or indirectly conditioned.

Temperature and humidity sensors were installed in the attic, in the conditioned rooms below, and outdoors. Electrical consumption monitors were installed at the air handler and the outdoor heat pump unit.

Data collection began at the end of August 2006. Every three weeks, the motorized dampers in the attic were adjusted so that the attic alternated between being directly conditioned and indirectly conditioned (see Figure 5).

Direct Conditioning Provides No Benefits

Broniek's data show that direct conditioning of the cathedralized attic wasted energy and provided no discernable benefit: "The analysis of energy performance and environmental conditions information found no advantage to directly conditioning a cathedralized attic located in a hot humid climate over having it indirectly conditioned."

When the attic was directly conditioned during the cooling season, the attic ended up being the coldest part of the house. Even though the thermostat was set at 76°F, the attic temperature dropped as low as 66°F.

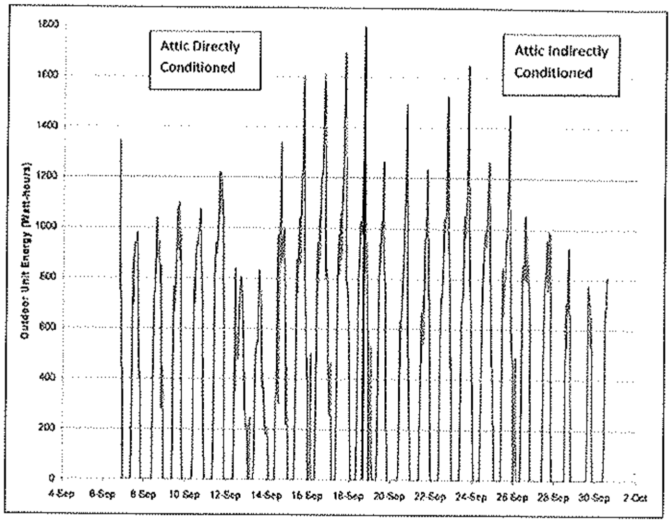

Figure 5. This graph shows energy use measured at the heat-pump outdoor unit. Before comparing the energy use from different three-week periods, the data were normalized to account for weather.

When the attic was directly conditioned during the heating season, the attic ended up being the warmest part of the house, reaching a peak temperature of 87.6°F.

Direct conditioning of the attic required more energy use than indirect conditioning: "The difference in energy use between the conditioning cases is 9.3 kWh (per 169 cooling degree days) or 5.8%. If the difference in energy use between conditioning cases was extrapolated for the 3,508 cooling degree days experienced in Orlando in 2006 (CPC 2007), the total difference in energy use would be 193.8 kWh for the entire cooling season. Based on the local utility rate for the Orlando area of 8.9¢ per hour for the measurement period (FPSC 2006), the additional energy cost of directly conditioning the attic, instead of leaving it indirectly conditioned, would be $17.25 per cooling season."

A Cathedralized Attic in a Hot, Humid Climate — Is it Worth Conditioning? by John Broniek is posted online at *www.ibacos.com/pdfs/Conditioned%20Cathedral%20 Attics%20Final.pdf*.

NEW PRODUCTS

Problems Installing Cotton Insulation

By Tristan Korthals Altes

I bought some UltraTouch (*www.bondedlogic.com/ ultratouch.htm*) cotton fiber insulation a few months ago thinking that it would be a great natural product for the cabin I am building. This is the stuff that comes in blue unfaced batts, and is often said to use recycled blue jeans, although it uses pre-consumer denim from factory waste. I bought it from a (great) Brattleboro, Vermont retailer, Renew Building Materials and Salvage, for 88 cents a square foot. Unfortunately, the insulation is shipped from Arizona, but it seemed worth the effort.

Within a couple hours of working with it, however, I was ready to abandon it in favor of blown-in cellulose, and returned all of the unopened bags minus a restocking fee. What went wrong? Three things:

- It's too thin.
- It's too wide.
- It's hard to cut.

Too Thin

The worst flaw of the product is that it is too thin. I bought the R-13 batts that are supposed to be 3 ½ inches thick to fill the stud cavities in a standard 2x4 stick-frame wall. Just like the fiberglass insulation I've worked with in the past, the batts were compressed into a bag for shipping. You are supposed to be able to take them out of the package and they will "fluff up" to full size in a process called "loft rebound." However, that never happened (see Figure 6).

The actual thickness varies. At best it's 3 inches; at worst it's less than 2 inches. The photo, by the way, was taken after the batt has been sitting out, uncompressed, for six full months. It did all of its "fluffing" in the first few hours and hasn't improved since.

Not Really R-13

What's wrong with that if it's R-13? Well, it's not really R-13. The air pockets provide the insulation, not the cotton. If you take the same cotton and compress it into a smaller space, there are fewer air pockets and thus less R-value, as the cotton conducts more heat. That R-13 value is based on 3 ½ inches of fluffy cotton with lots of airspaces, not 2 inches.

Also, since the batts are so thin, they leave about half the stud cavity open. That massive air cavity (which remember, I already paid 88 cents per square foot to