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~ *Ventilation News and Views* ~
August, 2013

Cost of Ventilation

By: Paul Raymer

There is a lot of chatter going on in the building science community at the moment about "over ventilating" and the "cost" of ventilation.

It seems pretty clear that some mechanical ventilation is required as homes approach a zero natural ventilation rate. No matter how tightly we build them to save energy, we still need to breathe. If a house has no natural leakage, it is the equivalent of putting a plastic bag over your head. Eventually you will run out of breathable air. And, in fact, so will the house and all of the things in it. Without replacement air, the candle goes out.

At what point will a house leak enough air in and out naturally to support a safe and comfortable interior environment? The primary difficulty with that question relates to the amount of replacement air that the particular occupants need. We are required by the 2012 IECC code to tighten up houses to three air changes at fifty Pascals of pressure! That works out to a natural air change rate of about fifteen percent of an air change per hour. That's great for saving energy, but it's not so great for breathing.

Actually calculating the cost of mechanical ventilation isn't all that complicated. If you're going to use a high quality bath fan as your primary ventilation system, the fans use about the same electrical energy as a door bell transformer. And who counts those? So the electrical cost is not much of an issue. If you're going to run the air handler or an inefficient fan for your ventilation system, both the electrical cost and the conditioned air cost need to be included.

So what is the conditioned air cost for a 50 cfm fan running all the time in a new home in Boston? A cubic foot of air can hold 0.018 BTU. Since we're interested in cubic feet per minute we can multiply that by 60 and get to 1.08 BTUs per cubic foot per hour. Because homes are more energy efficient, we can use a 55 heating degree day base (instead of the traditional 65 degree day base) which for Boston is 3299 so we can multiply 1.08 times 3299 times our 50 cfm fan times 24 hours in a day to arrive at 4,275,504 BTUs for the year. If the house has a 95% efficient gas furnace, that would be about 43 therms of gas. And natural gas in Boston at the moment sells for $1.28 per therm so the total annual cost to condition the air for heat loss would be $54.75.

We can do a similar sort of calculation if we consider air conditioning when it gets too hot and we're going to keep the ventilation fan running. The cooling cost for Boston isn't as bad as other parts of the country, but the electrical cost is pretty high at about $0.18 per kWh. Cooling cost of the air for our 50 cfm fan would be about $53 for the year. So the total conditioned air cost for running a 50 cfm fan in Boston would be about $108 for conditioned air cost - for the whole year! Actually it's even less than that.

We're assuming that this is an exhaust style ventilation system, like a bathroom fan. It's going to pull air out of the house and at the same time it's going to be drawing an equal amount of outside air in. It's going to "depressurize"

the house. That means that some of the air that would be naturally leaking in and out through stack effect and wind load will be displaced by the mechanical ventilation system. So the natural infiltration will be reduced because 1 cfm in has to equal 1 cfm out. Although the natural leakage cost for our tight house is really low, there is a cost.

For example an 1800 square foot house built to a 3 CFM50 level will have a natural leakage of about 35 cfm. There is a 0.5 rule that was developed by Larry Palmiter at Ecotope and is beautifully illustrated by a bit of software called "See Stack" (developed by Collin Olson and Paul Francisco*) that says that you will add about half of the fan flow until the fan flow is twice the natural flow. So, if the 1800 square foot house has an average infiltration rate of 35 cfm, you are in fact adding only 25 cfm of new air with the 50 cfm fan that needs to be accounted for in the conditioned air cost calculation. That drops our conditioned air cost to just $54 per year - less than a tank of gas for your pickup!

Some people say that the new rates in ASHRAE 62.2-2013 will cause "over ventilating" but what does "over ventilating" mean? If we knew exactly how much air each of us needed at any one particular moment, we could establish that as our required ventilation rate. But really, what difference does it make? How do we set a value per cfm for occupant health, building durability, or comfort? Can we have too much health, too much durability, too much comfort? If the rates were really high we would have a draft which would be uncomfortable. Too much ventilation could dry the house out in cold weather, but how do you set a ventilation rate based on relative humidity which changes hour to hour, day to day, week to week, month to month, and year to year? The only metric we can reasonably evaluate is the cost of the energy. The fact is that a window costs more in energy than a solid wall. A one hundred watt television uses energy too. So does a refrigerator, a computer, a power strip, a door bell.

If the world is flat, one could argue about how flat it is, but until you know whether it is flat or round, that debate doesn't mean a whole lot.

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