July 11, 1999

Why Unvented Attics Are Not a Crazy Idea

Joseph Lstiburek

Sometimes you just have to color outside the lines. Unvented attics? You've got to be kidding. Well, actually, no. Unvented attics actually make a lot of sense. In humid climates, venting attics brings a great deal of moisture into the structure. Not venting makes this problem go away. In cold climates, venting attics brings in a great deal of snow. Not venting also makes this problem go away. In roof design with complex geometry's, venting roof assemblies can be extremely difficult. Not venting makes this problem go away. Ever try to install an air barrier in a complicated roof system? Even in hot-dry climates not venting attics can make sense. Of course in all of these cases you have to know how to do it right.

What about moisture? What about shingle temperature and sheathing temperature? What about the energy costs? What about the code? Yeah, yeah, yeah and yeah. O.k., everybody take a valium. We are not about to violate the laws of physics here; we are actually going to use them to our advantage.

We traditionally vent attics to prevent moisture build up in roof sheathing. Where does this moisture come from? In cold climates the moisture source is from the inside. In hot-humid climates the moisture source is from the outside. Not venting in a hot-humid climate to control moisture build up in roof sheathing is a no-brainer. In cold climates, building unvented roof assemblies requires understanding the dynamics of moisture. The key is roof sheathing temperature. If the underside of the roof sheathing, typically the first condensing surface is kept above the dew point temperature of the interior air-vapor mix, condensation and moisture accumulation will not occur (see associated figure).

What about shingle temperature? Well the obvious answer to that is don't use asphalt shingles. They're a dumb idea anyway. They burn. They're an energy heat gain nightmare. They are sensitive to ultra-violet light and can't be made to last more than 15 to 20 years despite what the warranty says. Anybody out there ever collect on a shingle warranty? They also off-gas horrible stuff. Hail just kills them. But they are cheap. And in cold climates, they are the roof coverings of choice.

In most hot-dry and hot-humid climates builders use concrete or clay tiles so the issue becomes moot. Ditto for steel, copper and wood roofing. Constructing unvented roof assemblies with these types of roof coverings is not a problem. With asphalt shingles, the operating temperature of the singles increases slightly – on the order of 2 to 3 percent. That means, that a black asphalt shingle roof that is typically at 150 degrees F, now will be at 153 to 155 degrees F.

However, that 3 to5 degrees F increase is important, since it translates into an approximate 15 percent reduction in the useful service life of the shingle. Where does all this come from? Well, a good rule of thumb in physics and materials science is that for every 10 degree C (18 degrees F) increase in the temperature of a material, you double the chemical potential. Potential for what you ask? Potential for bad things to happen is what – like a decrease in useful service life. Divide 3 degrees by 18 degrees and you get around 15 percent. On a 15 year shingle roof, that means you loose 2 to 3 years in the service life of the shingle.

Why is there only a 3 to 5 degree F increase in shingle temperature? Shouldn't it be much higher? Actually, no it shouldn't and it's not. Heat is transferred three ways: convection, conduction and radiation. Radiation is the dominant factor in roof assemblies. Venting your roof does not affect the radiation heat transfer. And the under side of the roof sheathing is not designed as an efficient plywood-to-air heat exchanger. When you measure the temperature of the air going into the roof and the temperature of the air going out and look at the overall air change (i.e. the mass flow rate), the heat removal by ventilation is pretty pitiful compared to the heat into the assembly from solar gain.

Now remember that all this is based on some simple rules of thumb. But all of this is backed up by some real consistent field observations. I have about 1,000 unvented roofs with shingles under my belt. Most of them are in CANADA – yeah I know, the laws of physics are different up there. But a lot of them are in NEW ENGLAND, MICHIGAN and COLORODO. Over a third of them are now over 10 years old – and they are doing fine. These roofs are constructed from rigid foam sheathing sandwiched between plywood or OSB. My own house is built this way (but not my mother-in-laws...we won't go there).

REMBER THERE IS A TRADE-OFF. I choose to give up the 2 to 3 years in the life of my shingles in exchange for better performance for the entire system. Not all people will want to make this choice. I already see their logic: Yes, I prefer mold in my house in Orlando in exchange for 2 to 3 years more on my shingle life; and yes, I want my shingles to be black or brown in Austin so that I can install a 1 to 2 ton larger air conditioner. Of course, there are people who also root for the Cubs – but we are slowly getting them out of the gene pool. These are also the same people who vent crawl spaces – but that will be the subject of another article.

Now, where the real effect of not venting roof assemblies is felt, is the temperature of the underside of the roof sheathing. Our field measurements and computer modeling show that the temperature of the under side of the roof sheathing increases between 10 and 20 degrees F. Why the huge difference here and not in the shingles? Well, compare the R-value of a shingle and the R-value of roof plywood. A temperature gradient can actually exist across the plywood. And, ventilation air on the underside of the roof plywood does remove heat. Take away the ventilation air, and you do increase the temperature of the underside of the plywood. But does this matter? Yes and no. Depends on the overall system design.

Unventing roof assemblies in most climates increases the air conditioning load on a typical home by approximately 3 to 5 percent. If the ducts are inside the conditioned

space and we are not worrying about mold, humidity, ice-damming or blowing snow issues, vent the roof and don't give up the 3 to 5 percent.

But if you are stupid enough to put ducts in attics, if you are stupid enough to put air handlers in attics, if you are stupid enough to hire interior designers and architects that design incredibly complicated roof structures that cannot be air sealed at the interior drywall because of jigs, jogs, shelfs, coffers, pot lights, valleys, hips, dormers, beams, skylights etc. and etc. and etc., give up the 3 to 5 percent. Guess what you gain? You gain between 10 and 30 percent savings from the airtightness of the roof sheathing and lack of conductive gain on ductwork in vented attics.

In Las Vegas we are averaging utility savings of 20 to 30 percent on the cooling side with our unvented roof designs. Bye-bye duct leakage. Oh, the ducts still leak, but they don't leak to the outside. Bye-bye conductive gains on the ducts. The ducts are inside 75 degree attics. Yeah, but the surface area is larger and the attic volume is added to the house. Big deal – those trade-offs are nothing compared to the ease of constructing an air tight roof. The roof sheathing is now the air barrier (or the pressure boundary if you prefer that term).

In the humid south you also gain the humidity control. In fact, in the humid south you do not have any other intelligent choice. Unvented is the way to go. We've been fixing moldy houses in the humid south by turning vented attics into unvented attics for over 15 years.

The last problem is the code. The code does not like unvented roof assemblies. Not yet anyway. But changes are coming. First it was the 1997 edition of ASHRAE Fundamentals. Check it out, it likes unvented roof assemblies. We – the Building America guys and gals – changed the building code in Las Vegas. We have over 300 unvented roof assemblies constructed there so far. Building unvented roofs is now O.K. in Tucson, Phoenix, and Aspen. Building departments are accepting the approach on a one-on-one basis all over. In five years the codes all over will have changed.

Guess who hates all of this? The shingle manufacturers and the roof vent manufacturers. Duh.

(Joseph Lstiburek is an engineer and the principle investigator for the Building America Building Science Consortium)