Vapor Barriers and Condensation: Part I

Science and common sense point the way to effective strategies.

I think a lot about vapor barriers and dew points. It's an occupational hazard. For guidance in these matters I pore over arcane volumes of DOE conference proceedings and muddle through the *ASHRAE Handbook of Fundamentals*. When puzzled, I talk to the experts in person. And to find out what the real world is doing, I talk to builders around the country. At times, it's rather confusing.

Over the phone and at recent conferences, I've heard builders and designers ask many of the same questions I've wrestled with. Few of these questions have definitive answers. Often good research is lacking or the theory, research, and anecdotes fail to confirm each other. In many of the case studies reported, the full story is not known. What was the relative humidity in the house with the rotting rafters?

But all the research and analysis has not been in vain. For the major issues, consistent findings are emerging. Better news still is that there is little cause for alarm. The energy-efficient housing stock does not seem to be rotting beneath our feet. Here are some of the frequent questions on the fundamentals of vapor barriers and condensation, with attempts at brief answers. Next month we'll look at more specific materials and applications.

Q: *When does condensation occur?*

A: When warm moist air hits a cold surface, or when vapor flow through a wall gets dammed up and sufficiently cooled. To find the dew point for a given air temperature and relative humidity (RH), you need a chart or graph. There's a good one in *Solar Age*, 1/84, p. 47.

Q: *Where does condensation occur?*

A: On cold interior window surfaces and within walls and roofs. In walls, condensation occurs generally on the inside of the sheathing or on the back side of the siding. In summer, with air conditioning, the situation may be reversed in very humid climates and condensation can occur on slab floors and under wallpaper. It is possible for condensation to drip and collect on wall plates or under windows.

Steve Bliss is an associate editor at Solar Age.

Q: *Is condensation a serious problem?*

A: Mildew and wood-staining fungi will grow well on a wetted surface at 60°F and 60 percent RH. For wood-eating fungi to grow, though, wood fibers must be saturated (about 30-percent moisture content) and warm. These decay-causing fungi grow fastest at 50°F to 60°F, but some experts say they can do their thing as low as 32°F. You need consistently high humidities and cold temperatures in combination with an inadequate vapor retarder to produce this level of concealed condensation.

Q: *How does the moisture get into the wall?*

A: Water vapor generated in the home in winter moves outside by passing directly through permeable materials (by a process called diffusion) and by leaking out doors and windows and gaps in the building shell (carried by the air it is a part of). In most cases, air leakage moves far more water vapor than does diffusion, which is a relatively weak process. Diffusion is the movement of water vapor from areas of higher to lower concentration, independent of air movement.

Q: *How can I predict what's going to happen?*

A: It's tricky. Even if you can do the math, many of the variables such as perm ratings and air leakage rates will not be precisely known. For example, doubling the thickness of materials more than halves the perm rating. Still, a simple model is useful for design purposes. One approach is to plot the temperatures through the wall on a graph and to overlay a plot of the dew point temperatures. Wherever the actual temperature falls below the dew point temperature, condensation may occur. This method is detailed in *ASHRAE Handbook of Fundamentals* and in the National Bureau of Standards Report BMS 63.

Q: *How common is condensation in insulated 2x4 and 2x6 walls?*

A: Researchers think that small amounts of liquid or frozen condensation (frost) occur normally.

Q: *So why haven't more wood-frame houses rotted away?*