The Causes of Condensation

Q: I have customers who complain about condensation forming on insulated windows and skylights. What should we look for in a window or skylight to prevent this problem?

A: *Steve Easley responds:* Windows do not cause condensation; it's high humidity that's the culprit. Understanding how condensation forms on windows will help you determine what should be done to correct the problem.

Moisture vapor in the air condenses on cold surfaces in a home where the air reaches its dew point. This is common when there is a large difference between inside and outside temperatures and when the relative humidity — the amount of moisture in the air relative to its temperature — of the warm side is high. Typically, the coldest surfaces in a home are on the windows — most often at the edges, where conduction is greatest. In extreme cases, when indoor humidity conditions are very high, chronic condensation at the edges of the glass can create a significant moisture problem that leads first to peeling paint, then to mildew and mold, and eventually to rot (**Figure 1**).

PHOTOS: STEVE EASLEY

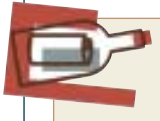
FIGURE 1. High indoor humidity levels, aggravated by a window blind that reduced the drying effect of air circulation, has created a condensation problem that has led to mold growth. In this case, the homeowner's lifestyle lies at the root of the problem, but it's not helped by an ordinary insulated window without warm-edge low-conductive glass.

Window condensation is more than a simple inconvenience to the person who is looking out the glass; it's a red flag that there could be serious moisture problems in the home as well. If condensation is forming frequently on the glass, it's likely to be forming inside walls where there are pockets of poor insulation and where air leaks are bringing warm, moist air into contact with cold surfaces.

Condensation can form in both very hot and very cold weather. On a cold wintertime night when the indoor temperature may be 50 degrees or more than the outside temperature, condensation on the inside edges of an insulated glass window is possible, depending on indoor humidity conditions. Similarly, on a hot Florida summer day, condensation may form on the outside surfaces of the windows of a heavily air conditioned home.

SOLUTIONS TO THE PROBLEM

You can reduce or eliminate condensation by changing the dew point — the point at which the



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water vapor condenses — either by reducing the indoor relative humidity or by increasing the thermal performance of the window. In the wintertime, you can do something about high indoor humidity — ventilate. In the summer, there's no way to control the high outdoor humidity, so the only solution is found in using high-performance windows.

The dew-point chart (**Figure 2**) helps to explain when indoor condensation will occur, depending upon the type of window. Look at the axis labeled "Indoor Relative Humidity (%)." The scale starts out from zero at the bottom, and goes all the way up to 100% relative humidity at the top. If the indoor relative humidity is greater than 50%, condensation may be inevitable, depending on the type of window. Above 65% RH, even the very best window available is at risk. And this high a humidity level indoors will likely cause other problems besides dripping windows. So, the first line of attack should always be to examine the humidity conditions in the home.

But although keeping humidity levels as low as possible in very cold weather is often the best strategy, it is not the only cure. Sometimes selecting the right window can do the trick. Single-pane glass (represented by the red curve on the bottom of the graph) combined with an average winter outdoor temperature of 30°F will produce condensation on the window when the inside RH is just over 30%. That's a pretty low indoor humidity level. In this case, simply switching to double-pane windows will solve the problem. Here's a quick look at window options:

If windows need to be replaced. Switch from an existing single-pane to a double-pane window. It's not uncommon to see condensation on old single-

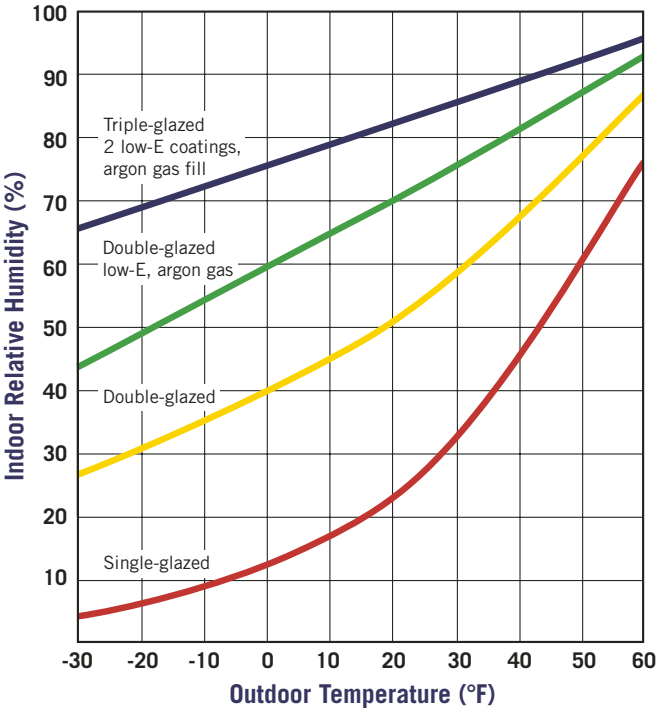

FIGURE 2. **DEW-POINT COMPARISON OF WINDOWS**
The colored lines on the graph above show when condensation will appear under different conditions on the window glass of four different types of windows.

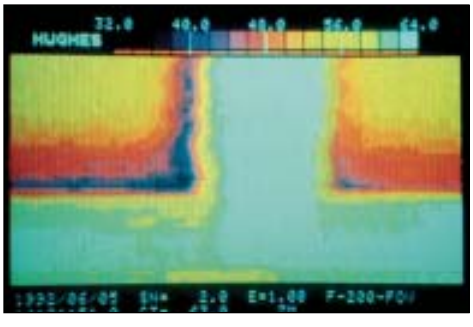

FIGURE 3. In the photos shown at left, the window on the far left (in both the photo and the thermograph) has a standard edge spacer — a highly conductive piece of extruded aluminum that quickly lowers the temperature at the edge of the glass and allows the indoor humidity to reach its dew point. The window on the right of each image has edge spacers often referred to as "warm-edge technology." These spacers conduct less heat, lowering the window's potential for edge condensation.

FIGURE 4. Prices for a digital hygrometer range from about $30 to $300, but a low-cost model such as this one is sufficient for most remodelers. This tool is primarily an aid for talking to clients about temperature and humidity and explaining the causes of condensation on glass even when it's not visible.

pane windows, even in normal humidity conditions. Switching to an insulated glass unit will often solve the problem.

In new construction. Invest in a window that uses warm-edge technologies to reduce conduction at the edges of insulated glass units. This can keep the window edges warm and reduce the chances for condensation to form (**Figure 3**). However, because condensation forming on the edges of an insulated glass unit indicates excessive moisture levels, it is usually better to solve the humidity problem before investing in window upgrades.

When upgrading. Choose an insulated glass unit with an argon or krypton gas fill, which provides a little better insulation value and reduces convection between the panels. This may be the best option for a window in a kitchen or bath, where even exhausting the humidity may not be enough to avoid condensation forming at the edges of the glass.

I recommend that contractors carry a digital hygrometer to measure and record indoor relative humidity while in customers' homes (**Figure 4**, page 18). These relatively low-priced tools can go a long way to communicating clearly with clients about the indoor environment and what the options are for fixing a problem.

LEGITIMATE CALLBACKS

Of course, there are callbacks associated with condensation that can be blamed on the window. The most obvious failure is condensation between the panes of glass in an insulated glass unit (IGU) caused by a broken seal. When the seal breaks, moisture-laden air leaks in and condenses on the coldest surface inside the IGU. The only cure is to replace the IGU (or usually the whole sash unit).

Sometimes the seal may break and the environmental conditions do not cause condensation inside the unit. Slowly, the low-E coating, which is typically put on one of the inside surfaces, will oxidize. This appears like a permanent smudge or fog that can't be wiped off. This, too, warrants a replacement of the unit.

Steve Easley is president of BMI, a company that consults with builders on field issues and provides training on building science.