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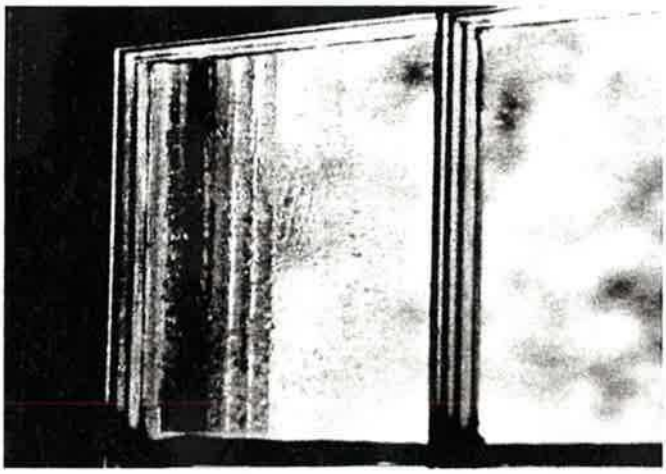
How to Avoid Window Condensation

Jeffrey L. Warner

Tired of those weepy windows? Selecting better insulating windows and eliminating excess moisture in a home are the cures for the condensation blues.

Condensation on windows can do more than disrupt the view. It can damage window frames and sills, interior shades and shutters, and even low-E window coatings and films. Water can deteriorate the surrounding paint, wallpaper, plasterboard, and furnishings. In severe cases, it can seep into adjoining walls, causing damage to the insulation and framing.



Cold Climate Housing Center

Condensation forms on a window when humid indoor air comes in contact with cool window surfaces.

Moisture in the Air

Annoying and damaging condensation is easier to prevent if one understands why it occurs. Air can hold varying amounts of water vapor or moisture. The warmer air is, the more moisture it can generally hold. The amount of moisture in the air, expressed as a percentage of the maximum amount the air could hold at a given temperature, is called its "relative humidity." For health and comfort, indoor air should contain some moisture. Its relative humidity should generally be about 30% to 40% at normal room temperature.

The relative humidity of air can be increased by adding more moisture or by reducing the temperature. When the relative humidity reaches 100%, the air can hold no more moisture, and water will begin to condense from it. The temperature at which this condensation occurs is called the "dew point temperature" of the air. When moist air comes in contact with a cold surface in a home, it may be cooled to its dew point temperature, resulting in condensation on the surface.

Windows don't cause condensation; they are simply the first and most obvious place it occurs. This is because windows generally have lower R-values (insulating values) than walls, ceilings, and floors. As a result, their inside temperatures are usually lower than those of other surfaces in a home during cold weather. If the air in a home is humid enough, water will condense from it when it is cooled at a window surface.

Increasing Window R-values

One can reduce the likelihood of window condensation in a home by selecting windows with higher R-values. Better insulating windows also help reduce heat losses from a home, thereby increasing comfort and decreasing utility bills. (For a detailed explanation of window types and their R-values, see "Consumer Guide to Energy-Saving Windows," *HE*, July/Aug '90.) The inside surface temperatures of better insulating windows remain higher during cold weather. The air adjacent to such windows is less likely to be cooled to its dew point temperature.

The better insulating value of multiple glass panes, low-E coatings and films, and gas-filled spaces between panes helps prevent condensation at the center of the window glass. Better insulating spacers—the components in the window frame that hold and separate the glass panes—help prevent condensation at the edge of the glass. Wood and foam are the best insulating materials for spacers. Fiberglass and butyl/metal spacers are not as good, but they are superior to traditional aluminum and steel spacers. The best frame materials for reducing the likelihood of condensation on the frame are wood and vinyl.

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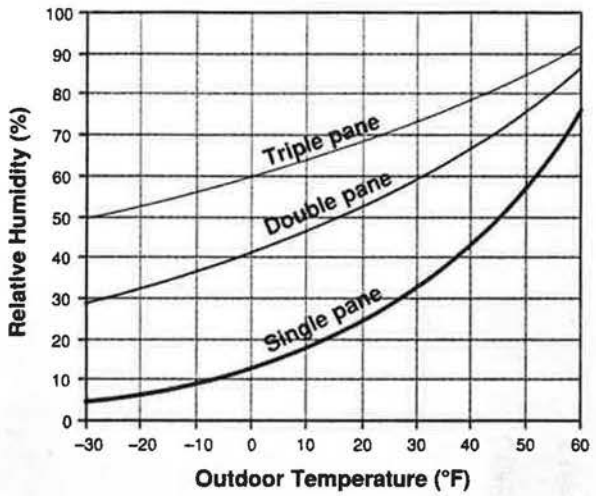


Figure 1. Outdoor air temperature and indoor air relative humidity combinations for which condensation will occur on the center of the glass of the three types of windows characterized below. On or below each curve, the conditions are right for condensation. Above each curve, condensation will not occur on that window type as long as the window is exposed to room air circulation.

WINDOW TYPES		R-Value
Glass Type	**Frame Type**	**(hr-ft²-°F/Btu)**
Single pane	Aluminum without thermal break	0.76
Double pane, ½ in. air space	Wood	2.04
Triple pane, 0.15 emissivity value for coating on two panes, ½ in. air spaces	Wood	2.78

Graphical data were calculated using WINDOW 3.1, a computer program for calculating the thermal and optical properties of windows. Graph is based on winter conditions: 70°F indoor air temperature, 15 mph outdoor air velocity, and no incident solar radiation.

Figure 1 shows conditions at which condensation will form on the center of the glass of three types of windows with widely varied R-values. The graph shows clearly that the better the insulating value of the glass, the lower is the chance of condensation at the center of the glass. Even at an outdoor air temperature of –30°F, the indoor air relative humidity must be nearly 50% before condensation will form on the triple-pane window type. On the other hand, at an outdoor temperature of 10°F, condensation will form on the single-pane window type at an indoor relative humidity of only 18%.

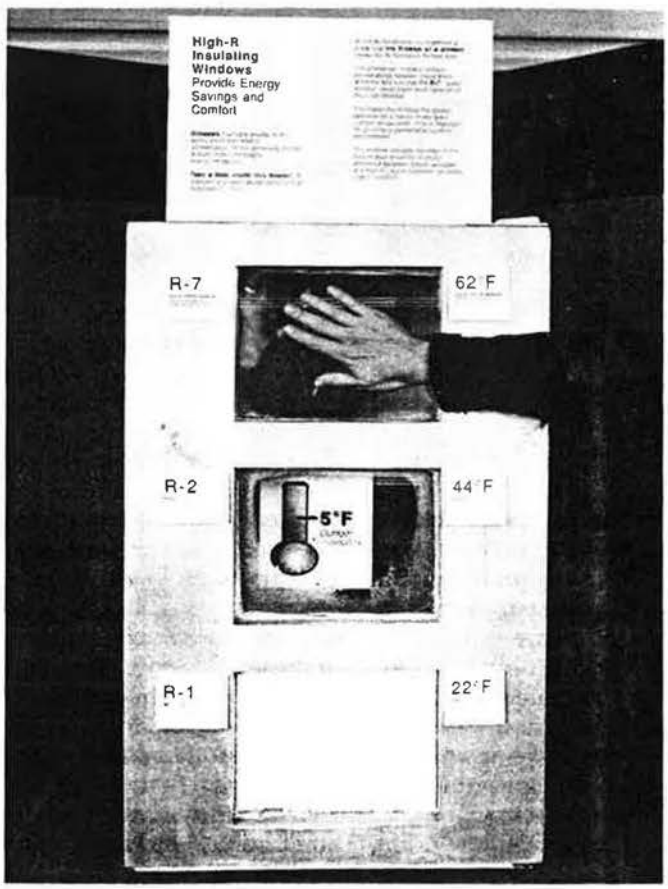
Eliminating Excess Moisture

Eliminating excess moisture in a home is a second way to head off condensation problems. Many factors contribute to moisture build-up in homes. Building materials such as wood, plasterboard, and concrete release significant amounts of moisture into the air, primarily during the first year after construction. Soil contributes moisture to homes through slab floors, crawl spaces, and basements. Proper foundation drainage limits moisture transmission into a home from below grade.

People, pets, and plants release moisture into homes. This is more likely to cause problems during the winter, when people spend more of their time indoors. Activities such as cooking, cleaning, washing and drying clothes, exercising, and showering boost indoor humidity levels. For this reason, windows in kitchens, bathrooms, laundry rooms, and recreation rooms are particularly subject to condensation. Opening windows slightly for ventilation during periods of heavy activity reduces the risk of condensation, but allows more heat to escape. House ventilation systems or exhaust fans installed in problem rooms are most effective in venting excess humidity to the outdoors.

Avoiding Other Window Problems

A number of other situations can make windows more susceptible to condensation. Figure 2 shows some



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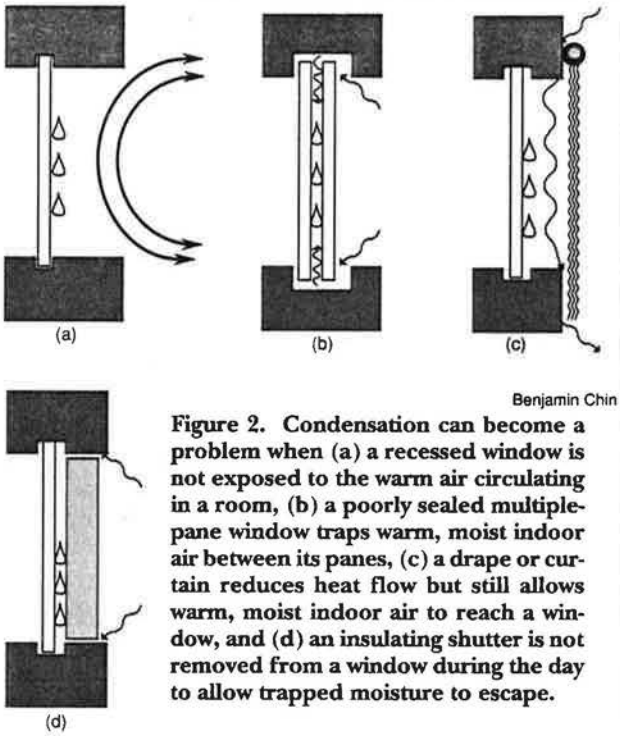
With a freezer interior representing outdoor winter conditions of 5° F, this display shows that the inside surface temperature of an R-7 Superwindow (top) is significantly higher than that of the double (R-2) glass window (middle) used in newer construction and the single (R-1) glass window (bottom) found in older homes. Energy-saving windows will also have little or no condensation or frost on the glass.

examples of possible condensation problems. Windows deeply recessed are isolated from warm air circulating in a room and remain colder on their inside surfaces, making them more subject to condensation during the winter. The possibility of condensation problems should be considered before recessed windows are installed in a home.

Warm, moist indoor air can leak into the spaces between panes of poorly sealed double- and triple-pane windows. The air becomes trapped against the colder outer glass surfaces and may fall to its dew point temperature, resulting in condensation between the panes. This condensation problem is best avoided by selecting and installing windows carefully and by caulking or weatherstripping cracks and joints around the windows.



Benjamin Chin

Figure 2. Condensation can become a problem when (a) a recessed window is not exposed to the warm air circulating in a room, (b) a poorly sealed multiple-pane window traps warm, moist indoor air between its panes, (c) a drape or curtain reduces heat flow but still allows warm, moist indoor air to reach a window, and (d) an insulating shutter is not removed from a window during the day to allow trapped moisture to escape.

If they are not moved for extended periods of time, drapes, blinds, and thermal shutters can promote condensation by restricting room air flow around windows. The inside window surfaces remain cold, and water may condense on them from the water vapor in the air that is permitted to reach them. Removing these devices from windows in the daytime allows moisture trapped at night to escape and prevents the build-up of condensation.

Lastly, outdoor barriers such as overhangs, fences, trellises, shrubs, and trees can shelter windows from the cooling effects of high winds and the cold night sky. In some cases, this type of sheltering can keep windows from falling too low in temperature and accumulating condensation. ■