FOGGED UP?

Clearing the Air About Window Condensation

By TOM FIEZA, ACI

This article is reprinted from the book "How to Operate Your Home."

EACH FALL, when we turn on our home heating systems, many of us experience condensation on windows: "steam" on the inside or, in extreme cases, water running down the glass. This condition may be only a temporary annoyance, but it could also signal serious moisture and window problems.

Where does all the water come from? Our parents' homes never had moisture problems, so why do we have them now? How can we solve the problems?

You can solve most condensation problems if you understand the basic principles of moisture and how it moves inside your home. Most likely, you'll just need to change a few daily routines. For serious problems, more extensive changes may be necessary: modifying windows, adding ventilation and improving heating equipment. The good news is that all moisture problems can be solved.

What causes condensation on windows?

"Steam" (condensation) occurs when invisible water vapor in the air condenses on the cool glass. Windows and metal window frames tend to be the coolest surfaces in our homes, so moisture forms there first — just like condensation beads up on the outside of your ice-cold lemonade glass in the summertime. *See Figure 1.*

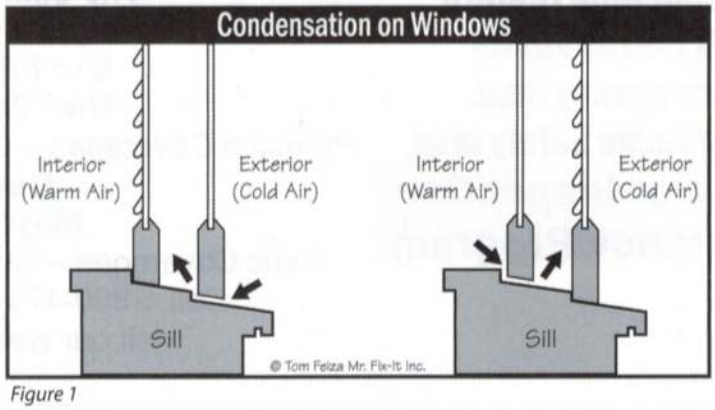


Figure 1

Condensation requires a cool surface and moisture in the air. This moisture is measured as a percent of the total amount that the air will hold at a specific temperature, and the percentage is known as relative humidity.

Warmer air holds more moisture. Cooler air holds less moisture. Weather reports refer to relative humidity and dew point. The dew point is the temperature at which the air is fully saturated with invisible water vapor and the vapor starts to become visible water (dew). When the dew point is high, air feels damp and wet, and we have high relative humidity. When the outside air temperature drops below the dew point, rain or fog appears.

Inside your home, when the temperature of the glass drops below the dew point of the inside air, visible moisture forms on the glass. The combination of a high level of moisture in the air and a cool glass surface triggers the condensation process.

More condensation occurs when there is more water vapor in the air and/or when glass surfaces become colder.

Solving the wet-window problem

For some lucky homeowners, window condensation is just a temporary annoyance. A few weeks after the heating season begins, interior air dries and condensation stops forming on windows.

In other homes, though, condensation continues, becoming a serious problem. Water runs off the windows and damages wood surfaces. Ice may form on windows and frames. Storm windows remained fogged up and icy all winter as water ponds between the frames. This serious condition needs to be addressed before it rots wood, supports mildew growth and damages the home's structure. To solve window condensation problems, you must reduce the invisible moisture in the air of your home and raise the surface temperature of the glass. Let's outline the steps you can take.

Reducing moisture levels – limit moisture sources

Moisture, fog, steam, ice, water vapor — they are all water in different forms. The most important step in solving moisture problems is to limit moisture sources.

Showers, cooking, washing and similar activities add lots of moisture to the air. Studies have shown that a typical family of four releases over 2-1/2 gallons of water per day into the air of their home. Damp basements, plumbing leaks, pets and plants all compound the moisture-generation problem. In fact, every time we exhale, we add moisture to the air. *See Figure 2.*

Start limiting moisture sources as follows:

- Cure damp basement or crawl space problems. Cover any bare crawl space soil with a plastic vapor barrier. Correct grading and drainage problems. Seal basement walls and floors. Ensure that the sump pump keeps the water level 8 to 12 inches below the basement floor.

- If your furnace has a built-in humidifier, turn it off. Also, turn off the water supply to the humidifier. Try leaving this humidifier off year-round unless your home becomes extremely dry. *See Figure 3.*

- Vent your clothes dryer to the outside. Don't air-dry clothes indoors.

- Eliminate plumbing leaks.

- Limit plants, aquariums and pets.

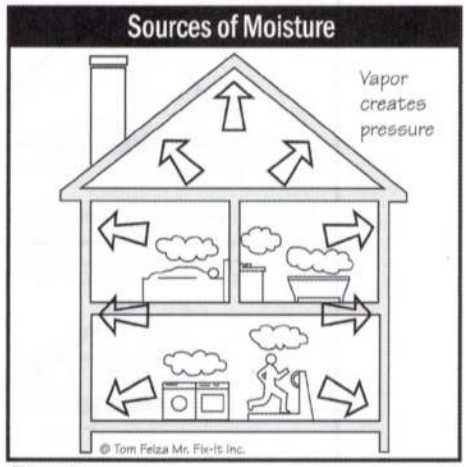
- Store firewood outside.

- Never use unvented fossil fuel-burning devices like kerosene heaters indoors. Burning fossil fuels creates carbon dioxide and water vapor, introducing excessive moisture into your home. It can also create dangerous carbon monoxide.

- Check gas-fired appliances (furnaces and water heaters) to make sure they are drafting properly up the chimney. A backdraft would release carbon dioxide and water vapor into the home. *See Figure 4.*

Reducing moisture levels – ventilation

If reducing moisture sources does not solve the problem, you need to increase ventilation. Structural ventilation or attic ventilation removes moisture from the structure of your home. Because moisture flows with air leaks and can push through many materials, general structural ventilation is important. Point-source ventilation removes moisture at specific sources. *See Figure 5, following page.* ▸▸



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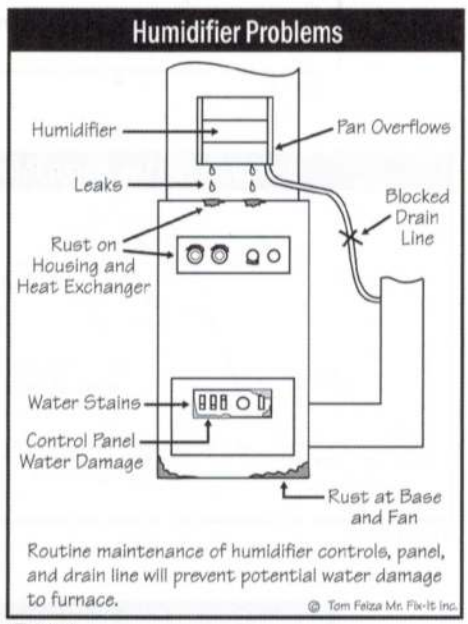

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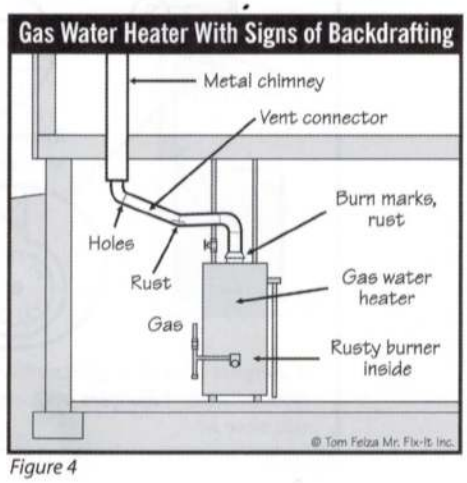

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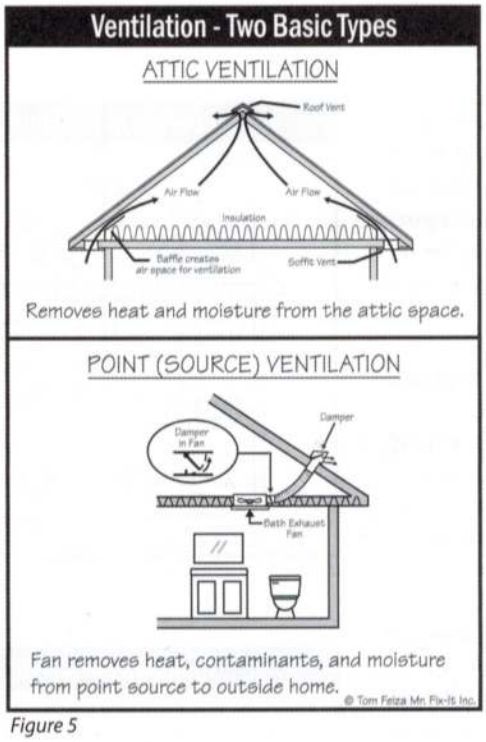

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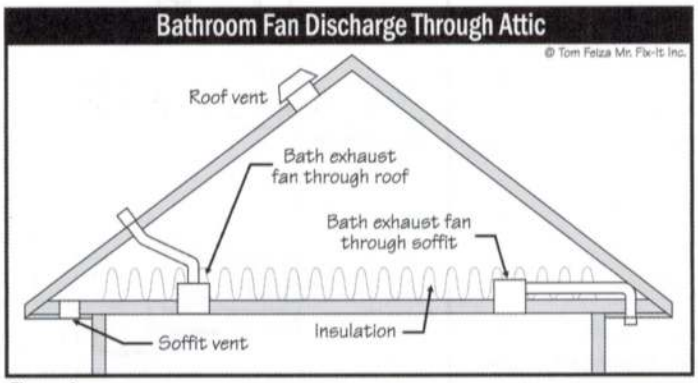

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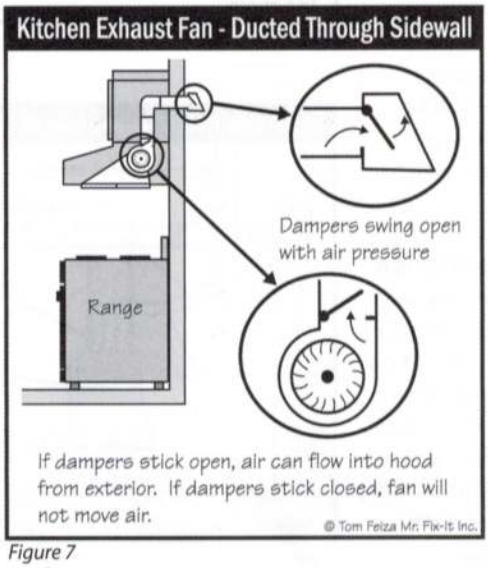


Figure 7

The following checklist addresses both methods of increasing ventilation:

- Use ventilation fans in bathrooms. Add fans if you don't have them, and route the exhaust outside your home. After a shower or bath, run the fan until the room is dry. This may require adding a timer switch in place of the regular fan switch. *See Figure 6.*

- Be sure kitchen exhaust fans are routed outside, and use them when cooking. *See Figure 7.*

- Evaluate attic ventilation. All bath and kitchen exhaust fans must exit the attic. There should be no hints of moisture (mildew or ice crystals) in the attic. In general, attics should have one square foot of free-air ventilation for each 150 square feet of attic floor space, or one square foot of ventilation per 300 square feet of attic space if there is a continuous vapor barrier. Half of the ventilation should be high on the roof and the other half in the overhangs. Make sure lower vents aren't blocked by insulation. *See Figure 8.*

- When the outside air is dry, open windows to "air out" your home and remove moisture.

- Consider keeping a window slightly open all winter long or whenever condensation starts to occur.

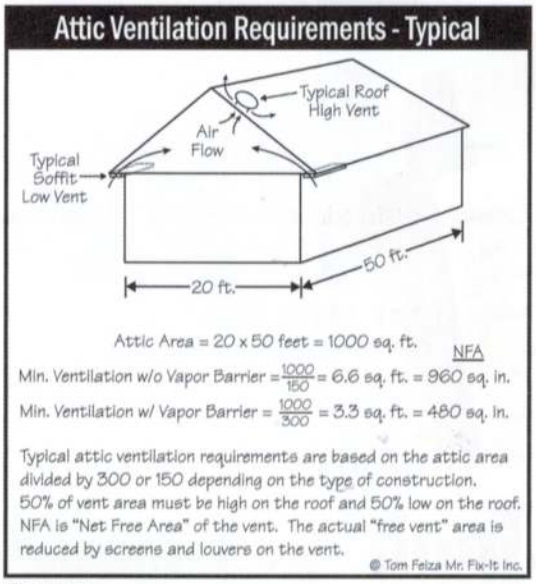
- Pick a window on the downwind side of your home. Air will be drawn out of that window without creating a draft. For a two-story home, select a second-floor downwind window instead of a first-floor window because warm, moist air rises. *See Figure 9.*

- Ventilate any sealed crawl spaces (except crawl spaces that open to the basement, which do not need ventilation to the exterior).

- Open the fireplace damper. Build a good fire to exhaust the stale, moist air in your home.

- Consider adding an outside air supply to your furnace air-return duct. Discuss this possibility with a heating contractor. When the furnace runs, this arrangement will draw dry outside air into the return duct of your furnace. The duct should be closed in the summer to prevent the entry of warm, moist air when the air conditioning is operating. *See Figure 10.*

- Consider forced ventilation with an exhaust system or a heat recovery ventilator. This upgrade is best left to professionals. It is only required when serious moisture problems can't be solved by any other method. *See Figure 11.*



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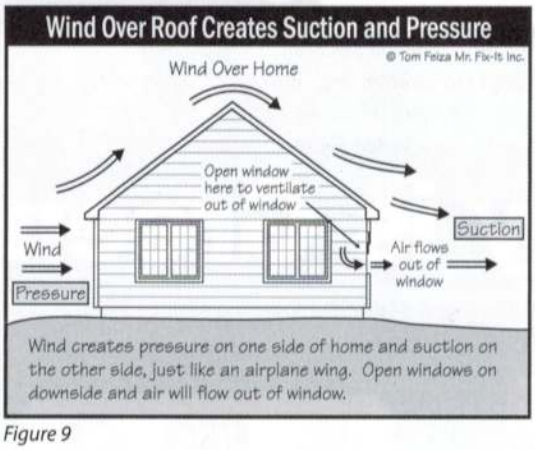


Figure 9

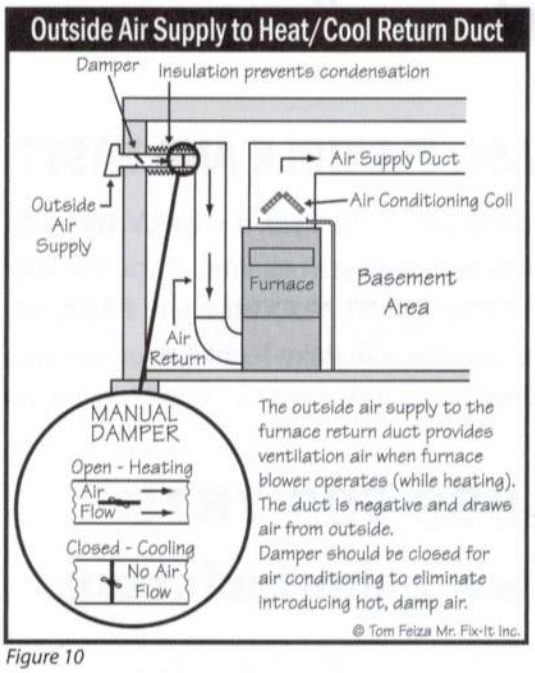


Figure 10

Mechanical moisture removal

Using a dehumidifier is an option, but you should consider it only if problems continue after you've increased ventilation. Dehumidifiers consume a lot of electricity, add heat to the space and are not very effective at temperatures below 65 degrees. They may also not be effective at the lower moisture levels found in most homes.

Reduce condensation by raising surface temperatures

You can also approach the condensation problem by raising the window-glass surface temperature. Remember, if you raise the surface temperature above the dew point, you will not have condensation.

Try these tips:

- Open curtains and drapes to increase air circulation around windows.
- Direct warm-air supply ducts toward windows or even use a fan for increased air circulation at windows. Operate ceiling fans.
- Add interior or exterior storm windows to raise the insulation value and increase the interior glass temperature. Metal window frames, in particular, may need storm windows to create a thermal break that stops the transmission of heat or cold through the metal.
- Raise the room air temperature by turning up the thermostat.

Why do modern homes have this moisture problem?

As we tighten our homes for energy efficiency, we reduce air exchanges. Modern homes are also wrapped with a plastic vapor barrier to stop moisture and air leaks. Most moisture moves with air movement, and a tight home just doesn't exhaust air and moisture.

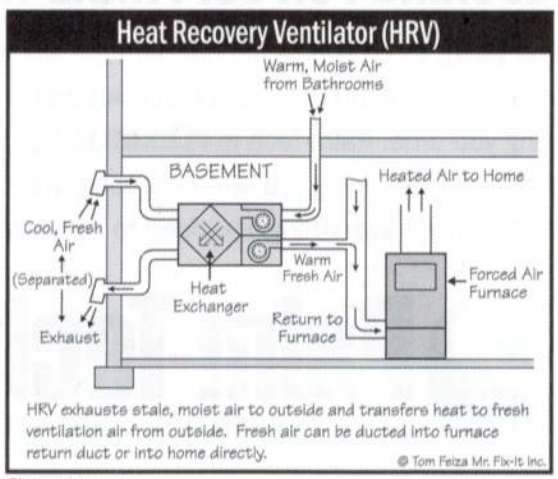


Figure 11

Older homes, with many air leaks and drafts, were constantly dry in the winter because of excessive air exchange. *See Figure 12.*

New windows and new furnaces are part of the ventilation picture. Tight windows limit air leaks. Furnaces that vent with two plastic pipes draw combustion air from the outside and don't exhaust air out a chimney flue. *See Figure 13.*

But don't blame the windows

Windows aren't the problem. They are just a cool surface delivering the message that excessive moisture is trapped inside a tight home. Your windows tell you when you need to reduce the moisture level.

Tighter modern windows do reduce air leaks, which limits ventilation and traps moisture. But tight windows also reduce heating costs, limit drafts and help keep our homes clean by stopping dirt infiltration. Modern windows with special glass may even reduce condensation problems because the glass temperature remains higher.

If you have old, single-glass windows or broken storms, shame on you. You deserve the condensation you get for wasting all that energy.

Expect extra condensation in brand-new homes

New homes present special problems. In addition to being built very tightly and allowing little air exchange, they trap construction moisture. When a home is built, much moisture is trapped in wood, drywall, concrete and other materials. It takes at least one full heating season to dry out a new home.

Why is the problem really bad in the fall?

In the fall, we experience cold snaps. When exterior temperatures change quickly, window-glass temperature also drops quickly, and condensation can form.

Also, when we first turn on our heating systems, all the higher summer moisture is trapped in wood, cloth, furniture and other porous surfaces. After a few weeks, most homes dry out and the problem disappears.

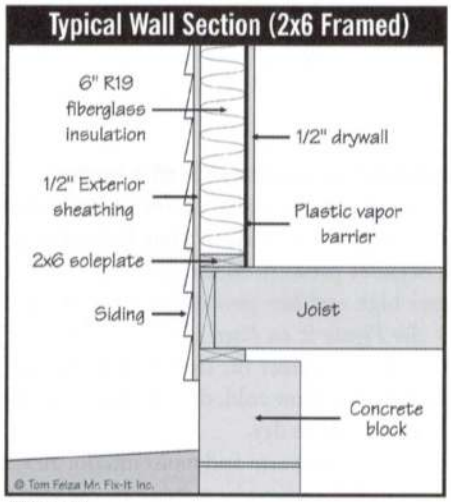
Why do bathroom windows fog up so readily?

Bathroom windows are subject to excessive moisture from showers and baths. This moisture condenses quickly on any cool surface, so the bathroom windows may fog while other windows remain clear. Use a bath exhaust fan to remove moisture. *See Figure 14.*

Why do windows in other rooms fog up mostly in the morning?

Windows fog up in the early morning because lower overnight temperatures cool the glass below the dew point. Later, when the outside temperature rises, the glass warms and condensation disappears as visible moisture evaporates into invisible air vapor.

If you "set back" (lower) the temperature inside your home overnight, you compound the problem by increasing the relative humidity and lowering the dew point of the air inside your home. ▸▸



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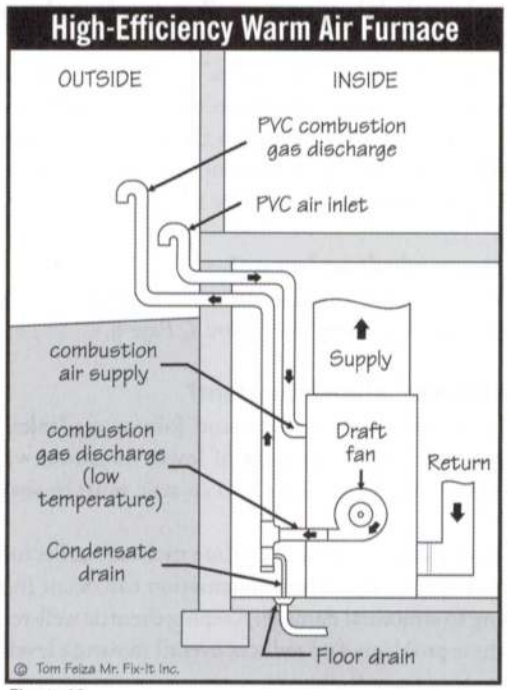

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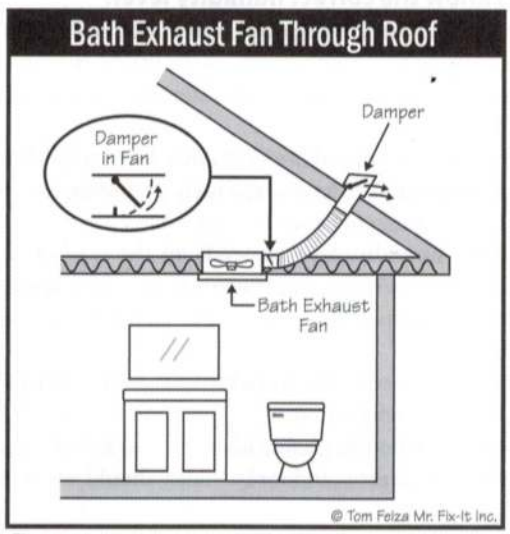

Figure 14

Why do windows fog on one side of a home?

This normally occurs on the inside of storm windows. Prevailing wind creates pressure on the side of your home facing the wind and creates a negative pressure on the downwind side. (The same principle causes high and low pressure around an airplane wing, creating lift.) *See Figure 9, on Page 11.*

Windows are not a perfect fit; they leak some air. Windows facing the wind tend to allow cold, dry exterior air to leak in. This keeps these storm windows dry.

On the downwind side, warm and moist interior air tends to leak from the inside window and can be trapped by the cold storm. The moist air condenses on the inside of the storm. (This is the window you want to keep slightly open to ventilate your home because the air will always push out without a draft.)

All storms should have "weep holes" at the lowest point of the window frames to allow condensation to drain from between the windows. These small weep holes can also ventilate the space and reduce condensation. Sealing the interior window will help eliminate condensation on the storm. *See Figure 15.*

Why do storm windows fog up?

When an interior window leaks warm, moist air, moisture condenses on the tighter, cooler storm. *See Figure 1, Page 8.*

Why is attic ventilation important?

Moisture moves through surfaces and follows air leaks. Vapor pressure pushes moisture to areas of lower moisture; warm air rises into your attic. All air leaks into an attic must be sealed. *See Figure 16.*

This means that your attic is a prime moisture collector. Since the roof deck is cold, excessive condensation can occur inside the attic, leading to structural damage. Keeping the attic well-ventilated bypasses these problems and reduces overall moisture levels inside your home. *See Figure 8, Page 11.*

How do I know the correct humidity level?

Watch your windows to gauge the correct humidity level inside your home. If condensation occurs on the inside of interior windows, you have excessive moisture and should take steps to reduce moisture levels.

Don't rely on cheap humidity indicators. Generally, they're not accurate. If the humidity level is too high, your windows will tell you with constant fogging and water problems.

The correct humidity level depends on the type of window, the outside air temperature and the inside air temperature. These temperatures are important because they affect the interior glass temperature.

When the glass is cold, the humidity level or dew point must be lower to prevent condensation.

For a home with double glazing (double glass) and an interior air temperature of 70 degrees, indoor humidity should not exceed the

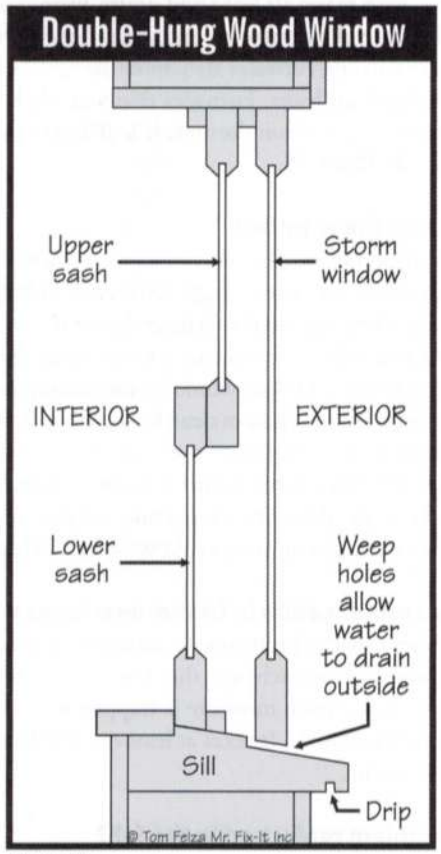

Figure 15

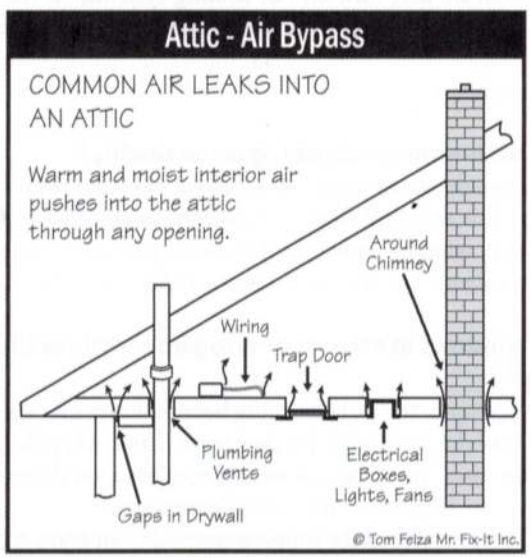

Figure 16

levels shown in the following guidelines. If humidity exceeds these levels, the windows will fog.

OUTSIDE AIR TEMPERATURE	MAXIMUM INTERIOR HUMIDITY
20 degrees F	40%
0	30%
-20	15%

If you have high-performance glazing or specially insulated glass, the interior glass temperature will be warmer because there is less heat loss. With a warmer glass temperature, you can raise the humidity level. If you have triple glazing, you can also raise the humidity level. With poor windows, you need to lower the humidity level.

Create a moisture balance

Every combination of home structure and family situation introduces an almost unlimited set of variables when evaluating condensation problems on windows. You need to try to understand the basics of moisture and condensation, limit moisture sources and properly ventilate.

Watch those windows! They will tell you when you need to take action.

Don't worry about temporary or short-term fogging of windows. Do worry if you have constant moisture problems and you notice water damage, mildew or water stains. Follow the steps outlined here, and consult a professional if you have persistent problems.

And don't condemn modern building practices and windows. Modern products and building techniques have given us comfortable, energy-efficient homes. While we enjoy our low energy bills, we simply need to understand how these homes react to moisture. ■

Tom Feiza is a registered professional engineer (PE, BSME) with over 35 years of construction and engineering management experience. He's known as "Mr. Fix-It" to loyal readers, callers to his weekly radio show, and audiences at home shows and conventions. An ASHI Certified Inspector with over 18 years and 6,000 inspections under his belt, he has published How To Operate Your Home, Home Systems Guide, Basic Home Systems, Home Systems Illustrated, and My Home – Mi Casa, and frequently presents at national and local inspection conventions.