

# Winter Moisture Problems

A Guide to Understanding and Correcting Moisture Problems



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## Winter Moisture Problems

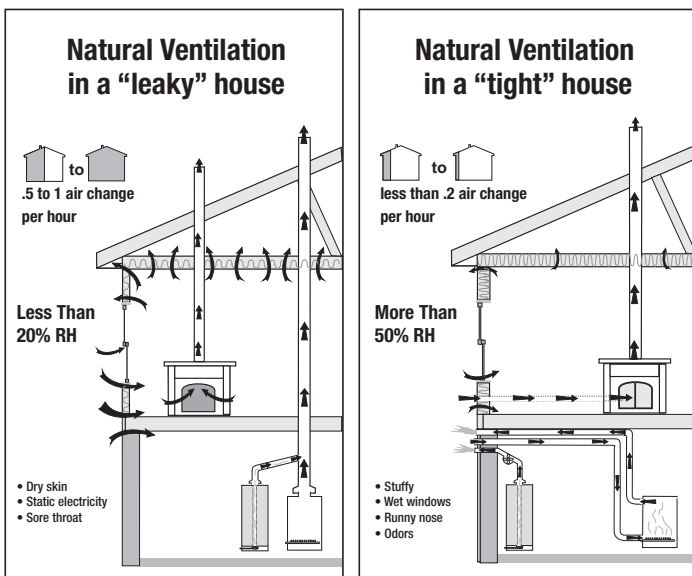
Wintertime humidity problems used to mean overly dry air that required adding humidity. Recently, tightly built, energy-efficient new homes and some remodeled and upgraded older homes have experienced wintertime problems caused by excessive humidity. The most common symptoms of excessive humidity is condensation or “fog” forming on the window glass.

The underlying reason for this humidity build-up is the reduced amount of outdoor air circulation through the structure. This air leakage is called natural ventilation. The amount of natural ventilation may be sufficient to provide acceptable air quality but not enough to correct the moisture problem. Conversely, a moisture problem may not exist in a home that requires additional fresh air for acceptable indoor air quality. Cold weather building scientists all agree that the healthiest, most energy-efficient home is built “tight” with mechanical ventilation to assure indoor air quality and moisture control.

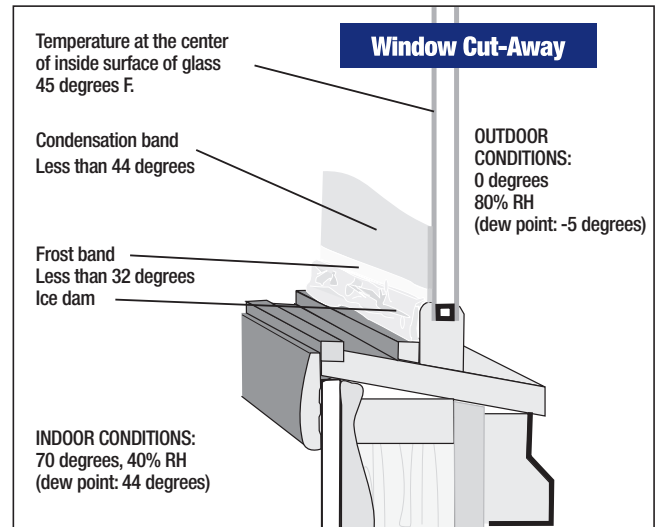
## Natural Ventilation

The amount of air that moves into and out of a structure is called natural ventilation. The amount of this ventilation is affected by temperature, wind speed, leakage area and open-combustion devices, so it is always changing. The natural ventilation rate is much higher on a cold and windy day than it would be on a calm and warmer day.

The natural ventilation in a structure is usually expressed as air changes per hour or ACH. If the natural ventilation in one hour is equal to the volume of the structure, then it is 1 ACH. For a 2,200 square-foot home with 8’ ceilings, 1 ACH would equal 17,600 (2,200 x 8) cubic feet per hour. To get the cubic feet per minute (CFM), you would divide 17,600 by 60 (minutes). The natural ventilation rate of this house is 293 CFM. The recommended ACH for a house is .35, or a third of an air change, according to the American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE). For this house, that would be 103 CFM. The higher the ACH the drier the house will become over the winter months. Typically, homes above .5 ACH will be “too dry”. If the ventilation rate is below .3, there will often be excess moisture build-up in the house. These homes may experience condensation on windows and other cold interior surfaces.



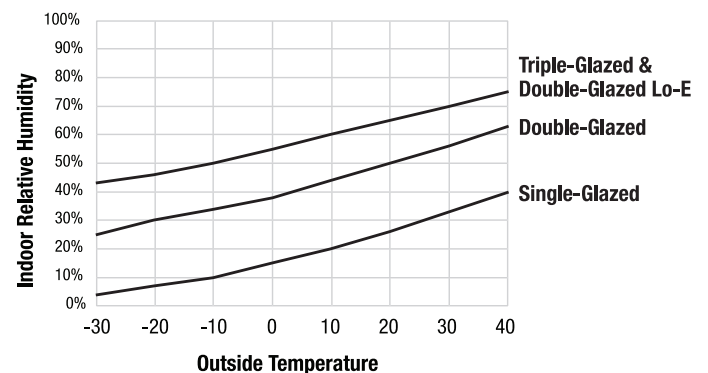
The wintertime humidity level present in a home is the difference between the indoor moisture load and the natural ventilation rate’s ability to remove it. Generally, “leaky” homes have high natural ventilation rates and low indoor moisture levels. “Tight” homes have low natural ventilation rates and high indoor moisture levels. The humidity levels can become high enough in “tight” homes that condensation will form on cold surfaces. In nearly all cases, the edges of the window glass are the coldest surface and moisture condenses there. (See the window cut-away) Curtains, drapes and window blinds will insulate the indoor surfaces of windows from the home’s heat. This causes the window surfaces to be even colder. In some homes, moisture will also condense on cold spots of outside walls and ceilings.



Temperatures will vary over the surface of the window glass. The center of the glass is the warmest area. The edges of the glass near the spacer are always cooler. The bottom edge of the window glass is the coldest area.

When condensation begins to form, it means the surface temperature is below dew point of the indoor air. Ice forms at 32 degrees, then a frost band may appear, but water droplets cannot form.

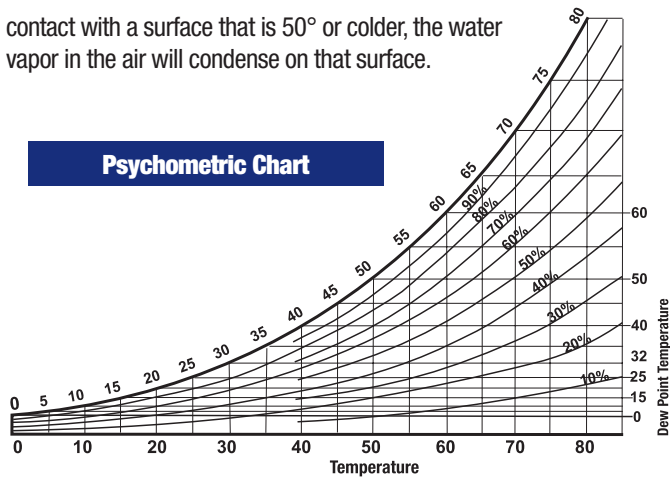
The chart below shows the conditions when condensation will form at the center of the window glass when the indoor temperature is 70



degrees. Remember, the center is the warmest part of the glass. The edges of the glass can be 10 to 15 degrees cooler than the center.

The psychrometric chart shown can be used to find the dew point of the air. For example, if your indoor conditions are 70°F with 50% relative humidity, then the dew point is 50°. Anytime this air comes in

contact with a surface that is 50° or colder, the water vapor in the air will condense on that surface.

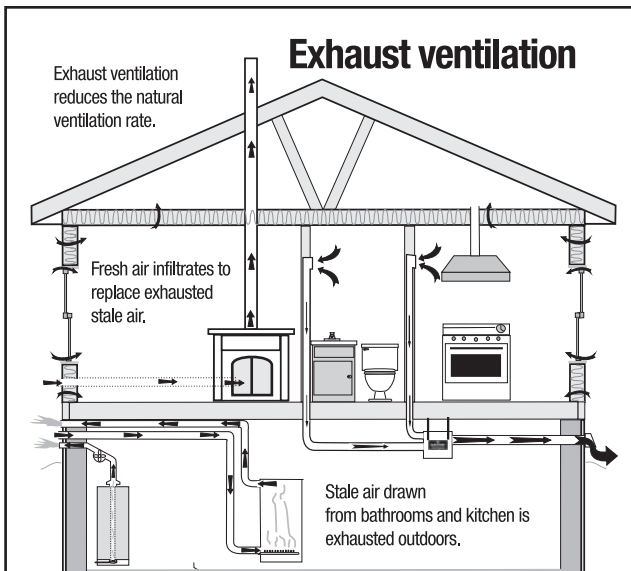


## Mechanical Ventilation Systems

The most cost-effective way to solve wintertime moisture problems and assure proper indoor air quality is to use some type of mechanical ventilation system. Two mechanical ventilation strategies commonly used are exhaust and supply ventilation. Each of these methods is illustrated below. Advice on how to size the ventilation system is on the following pages.

### Exhaust Ventilation

Exhaust Ventilation involves exhausting indoor air outside. Bath fans and ducted range hoods are simple examples of spot exhaust ventilation. The exhausted stale indoor air is replaced by infiltrating fresh air (make-up air). Ideally, stale air is exhausted from bathrooms and the kitchen. Fresh air inlets can be used to direct fresh air into bedrooms and other living areas. Make-up air can also be ducted to the central return duct of forced-air systems.



The spot ventilation provided by the occasional use of bath fans and range hoods is not sufficient to remove the high humidity found in “tight” homes. It is necessary to set up a ventilation schedule based on several factors including the size of the home, ventilation rate, and number of occupants.

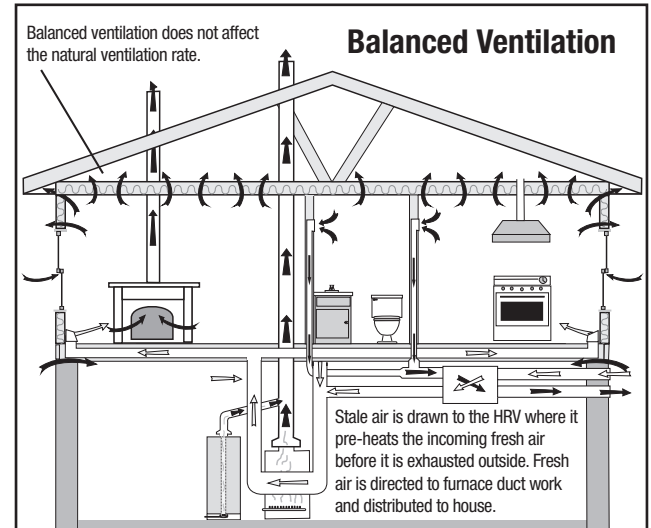
Exhaust and supply ventilation systems reduce the natural ventilation rate of the house by approximately 1/2 CFM per 1 CFM of mechanical ventilation. This makes control of the overall ventilation rate of the house more precise.

Extreme caution should be used in homes with open combustion

devices and fireplaces because of the potential of backdrafting carbon monoxide.

### Balanced Ventilation

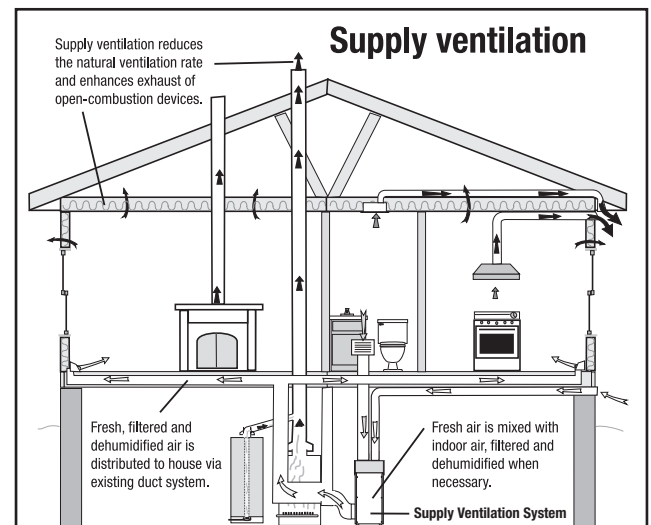
Balanced ventilation utilizes two powered air streams, one exhausting stale air out of the house and the other supplying fresh air into the house. The air volumes of each of these air streams should be the same, or balanced. The stale air is normally drawn from bathrooms and kitchen areas. The fresh air is directed to bedrooms or the ductwork of a forced-air system. Air-to-air heat exchangers, also known as heat recovery ventilators (HRVs), are the most common type of balanced ventilation in use because of the heat recovery feature. Balanced ventilation is safe to use with open-combustion devices because it



does not affect the natural ventilation that exists in the home. This also makes the overall ventilation rate of the homes more difficult to control. HRVs are among the most expensive forms of mechanical ventilation equipment. The unit cost combined with the relatively high installation costs for HRVs seldom offset the fuel savings that are realized from the heat recovery.

### Supply Ventilation

Supply Ventilation is the latest innovation in home ventilation. This system slightly pressurizes the house with a measured amount of fresh air to provide adequate air changes. The stale air is forced out of the house via bath fan and range hood ducts, flues, and fireplaces. This system enhances the air flow of open-combustion devices and reduces



the risk of back drafting. One CFM of supply ventilation also reduces the natural ventilation rate by 1/2 CFM. This provides more control of the overall ventilation rate of the home.

Supply ventilation systems can allow for the treatment of the fresh air before it is introduced into the home. Air filtration can remove pollen, dust, and mold spores. Year-round humidity control can also be achieved by dehumidification of the fresh air when required. This feature is particularly attractive for homes located in southern and coastal areas. Slightly pressurizing the home with dry air inhibits mold growth and structural damage common in humid climates.

## How Much Ventilation Is Enough?

There are many factors that affect the amount of ventilation required to correct wintertime moisture problems: the size of the home; the number of occupants; hours the home is occupied; the natural ventilation rate; lifestyle; and the moisture load from a variety of possible sources. On occasion, a high water table or a crawl space without a vapor barrier will require ventilation rates in excess of .35 ACH to correct moisture problems in the winter. In most cases, however, a ventilation rate that provides .35 air change per hour will correct wintertime moisture problems, so this is a good place to start.

First, determine the air volume of the structure. Take the square footage of living space multiplied by the ceiling height. For a 2,200 square-foot house with eight foot ceilings, this is 17,600 cu.ft.

Multiply the air volume of the house (17,600) by the desired air change rate (.35), this will equal the cubic feet per hour of ventilation that will provide the .35 air change rate (6,160). Since fans are sized in CFMs (cubic feet per minute), divide the hourly ventilation rate (6,160) by 60 minutes to find the cubic feet per minute (103 CFM).

This formula can under size the ventilation requirements of smaller homes. A good check is to multiply the number of occupants of the house by 15 CFM. For a family of five, this would be  $5 \times 15 = 75\text{CFM}$ . Always take the larger of the two ventilation rates.

This is the target average ventilation rate. Some houses will require more ventilation; some will require less. The ventilation rate can be “fine-tuned” late to fit the particular home.

Mechanical ventilation systems are available in a variety of CFM ratings. The CFM rating of the system should be larger than the target ventilation rate. If you were going to ventilate the example house with a 150 CFM exhaust or supply system, you would adjust the ventilation periods to reach the target ventilation rate. Over a twelve-hour period the example house requires about 72,000 cu. ft. of fresh air ventilation. A 150 CFM system will provide this ventilation in approximately eight hours of operation. Therefore, the system should be set up to operate eight hours over a twelve-hour period.

## The Dollars and Sense of Ventilation

The mechanical ventilation necessary to correct wintertime moisture problems and assure indoor air quality in “tight” homes adds some costs. There is the initial investment in the ventilation system equipment and installation, plus the increased energy costs of operating the system.

There is a wide spectrum of systems available that will provide the necessary ventilation. The ventilation strategy chosen and the particular features desired will determine the installed cost of the system. Installing a new high-capacity bath fan or adding a fan for supply air are the most economical. Heat recovery ventilators and supply ventilation systems with air treatment and filtration will be more expensive. These costs are normally known before the system is installed. The actual operating cost of the system is more difficult to identify and often misunderstood.

1,500 sq.ft. - 70 CFM of Mechanical Ventilation	2,000 sq.ft. - 90 CFM of Mechanical Ventilation	2,500 sq.ft. - 115 CFM of Mechanical Ventilation
Heat Recovery Ventilator: <b>\$26.70</b>	Heat Recovery Ventilator <b>\$34.32</b>	Heat Recovery Ventilator <b>\$44.24</b>
Supply or Exhaust System: <b>\$44.26</b>	Supply or Exhaust System <b>\$56.06</b>	Supply or Exhaust System <b>\$72.96</b>

All mechanical ventilation systems require additional energy costs to heat the make-up air. Heat recovery ventilators (HRVs) pre-heat the incoming air through heat exchange with the warm exhaust air stream. This reduces the energy cost, but additional heating is still required to bring the air up to the interior temperature. Supply and exhaust ventilation systems do not offer heat recovery, but they provide more control of the overall ventilation rate of the home because they reduce the natural ventilation rate. Homeowners generally fear the energy costs of properly ventilating their home will be very high so they often assume that they need an HRV to save these energy dollars. In reality, the operating cost of ventilating most homes is not expensive, and the operating cost difference between HRVs and exhaust or supply systems is not that great. The cost of not ventilating a “tight” home can be very high in regard to structural damage and the health of the occupants.

## Ultra-Aire Dehumidifiers

To prevent mold, mildew and bacteria growth in basements, and dust mites throughout the rest of the home, relative humidity levels in the Winter should range from 25-35% and in the Summer and Fall, less than 50%, as recommended by the EPA, American Lung Association, and the American Medical Association.

The simplest and most practical method of managing relative humidity and providing a healthy and comfortable environment is a ventilating dehumidifier. Different from conventional units, the energy efficient Ultra-Aire dehumidifiers connect directly into your existing HVAC ductwork for easy installation and moisture control for your entire home. Ultra-Aire dehumidifiers provides makeup air ventilation, air filtration, humidity control, and distribution to the home in one piece of equipment.



Ultra-Aire 100V



Ultra-Aire 90H



Ultra-Aire XT150H

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