RESEARCH & TECHNOLOGY

MOISTURE PROBLEMS AND SOLUTIONS
REMOVING EXCESS MOISTURE WITH VENTILATION

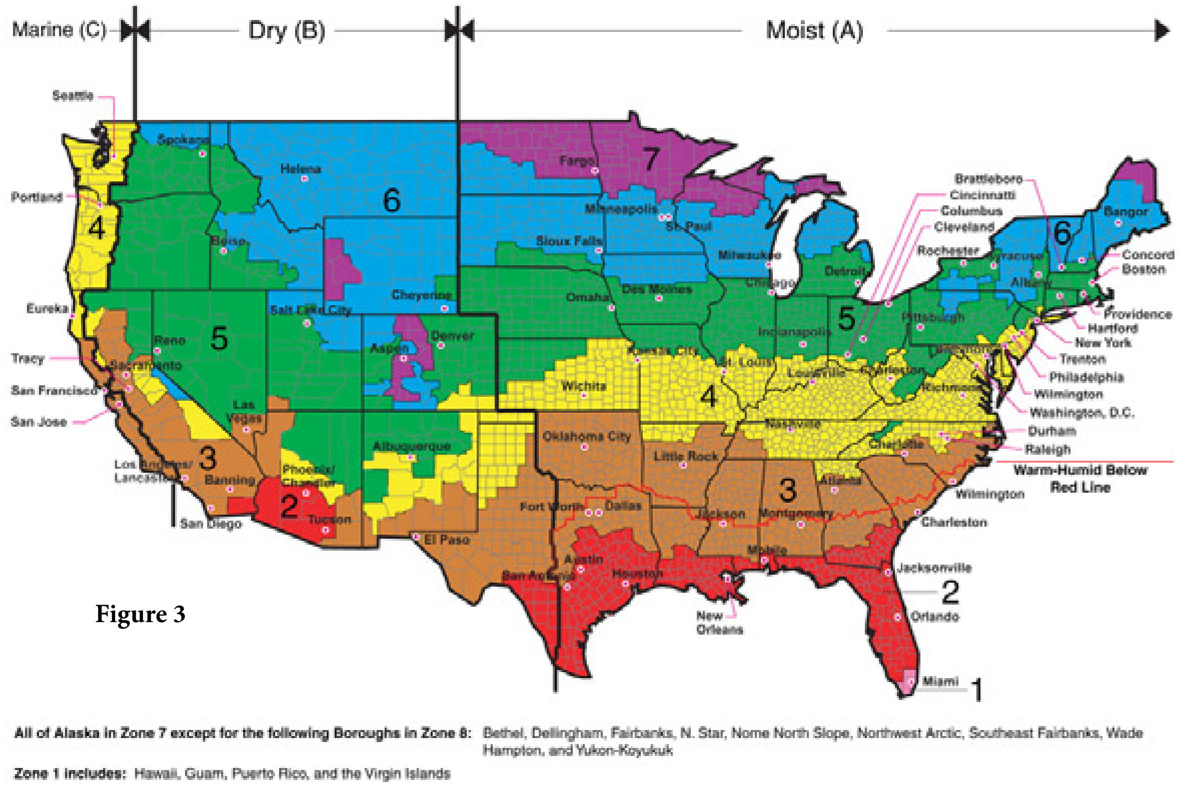

Figure 3

Removing any accumulated moisture is an important step in addressing potential moisture problems. Proper ventilation - removing inside air and replacing it with outside air - will safely remove excess moisture from inside the building system. But while air infiltration will ventilate a building, the exterior building envelope may be compromised by air escaping into the exterior envelope as discussed in 'Moisture Problems and Solutions – Keeping Water and Moisture Out' as published in the November 2023 Issue of Frame Builder Magazine.

Ventilation discussed in this article focuses on ventilation needs for the occupied space of heated facilities during cold weather. The heated occupied space provides for the activities occurring in the building. Ventilation of the occupied space is not the same as attic ventilation. Attic ventilation commonly exchanges air in the space/volume above an insulated ceiling and the roof. This attic space is outside the envelope of the heated occupied space and is not addressed in this article.

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An occupied space ventilation system needs to be operated to remove indoor moisture so that moisture does not condense on the inside of windows or exterior door frames (**see photo**) during winter. Exterior building components like windows and door frames often have lower R-values compared to exterior insulated wall sections. During winter weather, a building component with a lower R-value will usually have a lower inside surface temperature compared to inside surface temperature on components with higher R-values. This difference in surface temperatures caused by different R-values is why condensation will form on windows and door frames before it forms on insulated wall areas.

When the surface temperature of the building component is lower than the dew point temperature of the air inside the building, condensation will form on the inside

continued on page: 19

Photo 1

surface of the component. Psychrometrics provides an understanding of the relationship of air-moisture mixtures and dew point temperature. Basic psychrometrics can be studied using a simplified psychrometric chart shown in **Figure 1**.

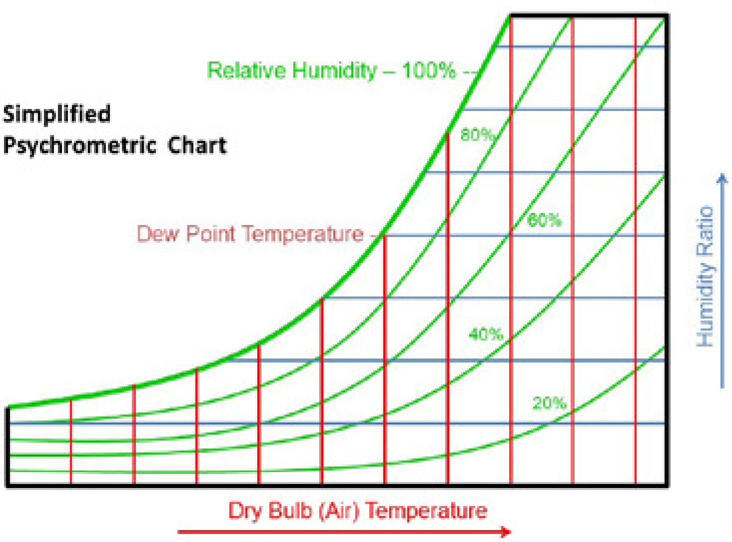
The science of psychrometrics

Air temperature (red lines) increases from left to right, and the amount of moisture that air can hold increases as air temperature increases.

The relative humidity (green lines) indicates how full the air is of moisture at a given air (dry bulb) temperature.

The humidity ratio (blue lines) increases from bottom to top and indicates the actual amount of moisture in the air.

Figure 1

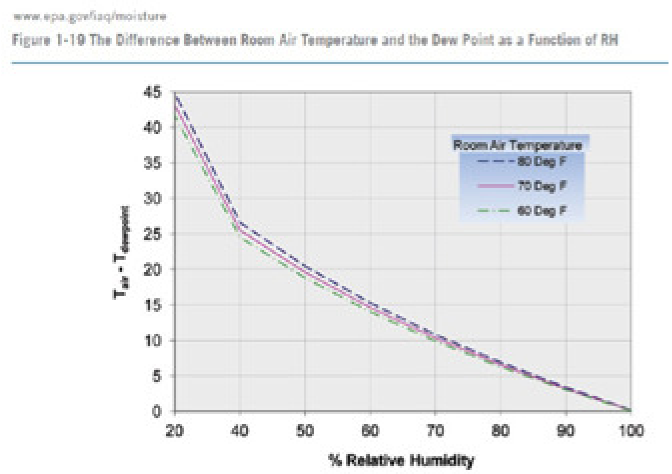


The dew point temperature (purple letters) is found where the humidity ratio line intersects with the 100% relative humidity line with the dew point temperature being the air temperature at the intersection. Dew point temperature is the air-moisture mixture property that indicates when condensation will occur. A surface that is cooler than the dew point temperature of the air in contact with the surface will have condensation form of the surface. If a surface is warmer than the dew point temperature of the air in contact with the surface, the surface will remain dry (no condensation).

The air state point is located where the air temperature line intersects with the relative humidity line. A humidity ratio line that intersects with the air state point is followed horizontally to the line to the 100% relative humidity line to determine the dew point temperature at the air temperature and relative humidity used to find the air state point.

When the relative humidity is less than 100%, the air temperature will be higher than the dew point temperature. The difference between air temperature and dew point temperature as a function of relative humidity is shown in **Figure 2**.

Figure 2



The bottom line

To minimize condensation on inside surfaces of exterior building components, one wants to operate a building such that the inside dew point temperature is lower than the inside surface temperature of any exterior building component. The inside air temperature will be similar, to somewhat higher, than the inside surface temperature of all exterior building components. A large difference between air temperature and dew point temperature exists by maintaining a low indoor relative humidity (**Figure 2**).

The required difference between dew point temperature and inside air temperature depends on the weather conditions and R-value of the building component. The climate zone map, given in **Figure 3**, provides some insight into the required minimum R-value of a window or door frame. Colder zones should have higher window and door minimum R-values.

A higher R-value will result in a higher inside surface temperature. This allows indoor air to have a higher dew point temperature before condensation begins to form.

continued on page: 20

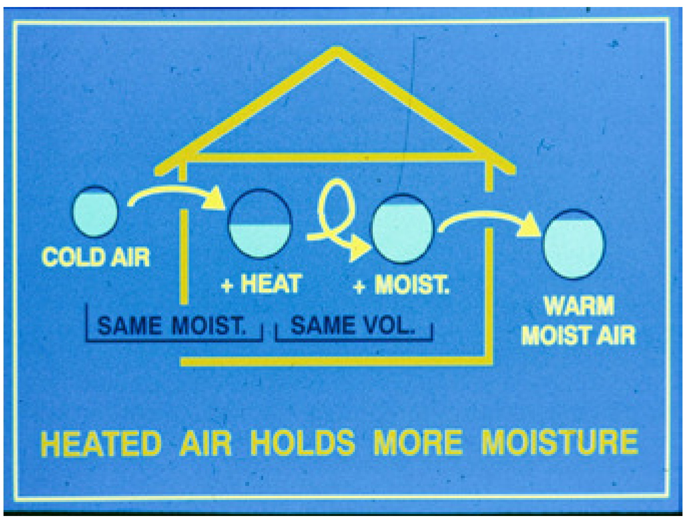
continued from page: 19

RESEARCH & TECHNOLOGY

Once a building is constructed, not much can be done about increasing the R-value of a component. If condensation is forming on the inside surface for an unacceptable amount of time, then one must use ventilation to remove moisture from inside the building. A properly operating ventilation system will decrease the inside dew point temperature as moisture is removed. The amount of ventilation needs to be high enough so that condensation no longer forms on the inside surfaces.

The reason a ventilation system can remove moisture from inside a building can be graphically seen in **Figure 4**. When air is heated (increasing the air temperature), it can hold more moisture. The heated dry air from outside can absorb indoor moisture and will remove moisture from the building when the air is exhausted out of the building. This type of ventilation exchanges air by removing inside air and replacing it with outside air.

Figure 4



Summary

Building ventilation is done to:

- Remove excess moisture
  - o And must be continuous when a continuous moisture generation source is present
  - o Or can be intermittent to control periodic indoor moisture problems
- Improve and maintain indoor air quality

The amount of ventilation needed depends upon several of the following factors:

- Moisture generation rate
- Moisture generation duration – continuous or intermittent
- Air temperature rise from outside to inside

A properly sized ventilation system has just enough capacity to remove the excess moisture generated inside the building while maintaining adequate indoor air quality. Keeping the ventilation capacity correct will minimize the amount of supplemental heating required to maintain the inside temperature during winter.

All ventilation systems have the following five functional components:

1. Inlet – location(s) for air to enter the building space
2. Outlet – location(s) for air to leave the building space
3. Driving Force – reason air moves through the building space (the force that moves the air)
4. Distribution – how and where air moves through the building space
5. Path – how and where air moves through the building system

A properly operating ventilation system will include all five functional components. Experience has shown that most operational ventilation system problems can be traced to the inadequacy of one or more of the functional components.