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Condensation in Exterior Walls

Introduction

All air above 0% relative humidity contains water vapor. At any given temperature and pressure air can contain a maximum amount of vapor, which is its saturation point. If the temperature of saturated air is increased its ability to contain water is raised and additional vapor can be absorbed. If the temperature of saturated air is decreased its ability to contain water is lowered and the excess moisture condenses as liquid water. Condensation must be controlled to protect exterior wall assemblies from water damage.

Relative Humidity and Dew Point

Relative humidity is the ratio of the amount of water vapor in air to its saturation point at a given temperature. For air with a fixed amount of water vapor, the relative humidity increases as the temperature is lowered and decreases as the temperature rises. Air which is saturated has a relative humidity of 100%.

If the temperature of unsaturated air is lowered sufficiently its relative humidity will reach 100%, which is the air's dew point. The dew point is important because it is the temperature below which condensation will occur. If the dew point occurs within a wall the wall materials at that point will become wet, which can cause material damage, reduced R-value of insulation and mold.

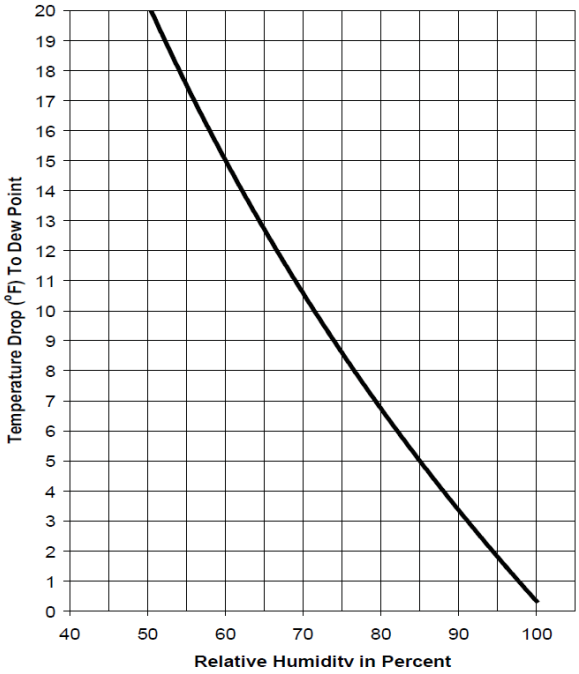
The drop in air temperature required to reach dew point and cause condensation is shown in Figure 1. For a relative humidity of 80%, a drop of 7 ^{o}F is required. For a relative humidity of 50% a drop of 20 ^{o}F is required.

Wall Construction and Detailing

Conventional exterior wall systems are not designed nor constructed to be air tight, and air and water vapor will migrate through a wall assembly in a number of ways. Vapor pressure drives vapor from areas of higher moisture content to areas of lower moisture content. Mechanical system pressurization drives air in or out of the building. Wind creates areas of high and low pressure

'Leakier' walls will permit the entrance of more air and vapor than 'tighter' walls, so exterior walls should be designed to be as airtight as possible. Some infiltration is inevitable, however, so wall assemblies should be designed with the means to control vapor's flow within the assembly and a means for vapor to exit.

One way of controlling the transmission of moisture vapor is the installation of vapor barriers or retarders. Water vapor diffuses through the wall assembly in proportion to each element's vapor permeance. A vapor barrier has no permeance and is intended to stop vapor transmission. A vapor retarder has a low permeance and is intended to slow or interrupt vapor transmission. Care must be taken to locate barriers and retarders where vapor will not be trapped at temperatures below the dew point in either heating or cooling seasons, and the vapor must have a way to dissipate. The selection of barrier vs. retarder, and the location within the wall



system relative to insulation and other elements is dependent on climate and wall system design, and is determined by dew point analysis. Barriers and retarders must be installed continuously, tightly sealed and undamaged to be effective.

Cold spots or thermal bridges within walls can create areas where air temperature is lowered to the dew point and condensation occurs. An example is steel studs in a wall without continuous exterior insulation. Although the wall may have adequate insulation, the cold studs will cause areas of localized condensation.

The possibility of condensation can be reduced by:

- Reducing excess humidity in the building, which may be caused by inadequate ventilation or system malfunctions.
- Design the wall system so that the dew point is within rigid insulation or another appropriate material where condensation will not occur.
- Use vapor barriers and retarders to control the transmission of vapor in locations where analysis indicates a probability of condensation.
- Increasing the temperature of the surface on which the condensation occurs by increasing the R-value of the wall or reducing thermal bridging.

Reference

1. Condensation – Prevention and Control, Technical Notes on Brick Construction, June, 2006,