Moisture in the Building Envelope

Moisture in the building envelope can cause the following problems:

- Mold & mildew
- Corrosion
- Rot
- Insects
- Staining
- Freeze-thaw damage
- Delamination & adhesion loss
- Loss of thermal resistance

The most common sources of moisture are:

- Water leaks
- Air leaks
- Vapor diffusion (and condensation)

Leaks in the Building Envelope

Leaks (for example, around a window frame) can introduce water into the building envelope assembly every time it rains. Construction and design techniques which minimize the effect of leakage include redundant water exclusionary details, drainage planes, through-wall flashing, and weep holes. Avoid moisture trapping assemblies and double vapor retarder construction.

Air Infiltration

Air contains water vapor. If air is cooled to its dew point, water vapor will condense into liquid water. Within a building envelope assembly, there is usually a temperature gradient; that is, the temperature varies within the assembly. If air infiltration allows humid air to enter the building envelope assembly and the air is cooled to its dew point, condensation will occur and liquid water will accumulate within the assembly.

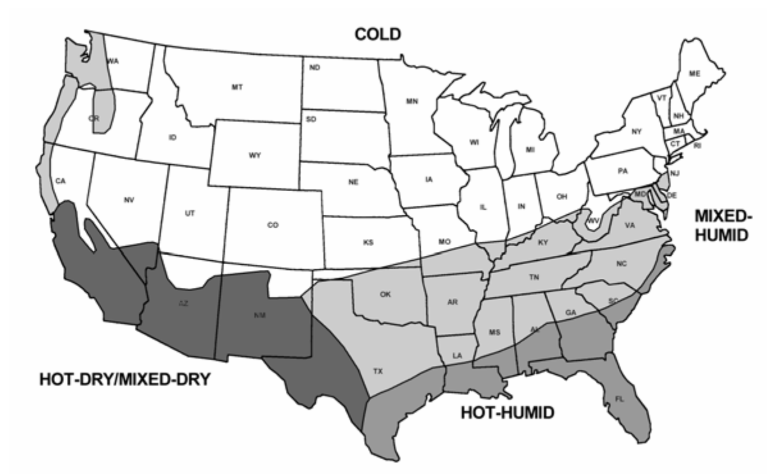
Example 1: During summer, a wall assembly in Florida (Hot-Humid Climate Zone) separates an air conditioned room at 72 ^{o}F from the outside air which is at 90 ^{o}F and 80 % relative humidity. The outside air has a dew point of 83 ^{o}F. If air leaks into the wall assembly (via infiltration) and contacts a surface at 83 ^{o}F or less, liquid water will condense and accumulate at that point in the wall assembly.

Example 2: During winter, a wall assembly in Michigan (Cold Climate Zone) separates interior air at 70 ^{o}F and 40 % relative humidity from exterior air at 20 ^{o}F and 50 % relative humidity. The inside air has a dew point of 45 ^{o}F. Where air leaking from the interior toward the exterior contacts surfaces colder than 45 ^{o}F, water vapor will condense and wet the wall assembly.

Properly installed and positioned air barriers will prevent air infiltration.

Water Vapor Diffusion

Water vapor diffusion is the movement of water vapor molecules from regions of higher absolute humidity to regions of lower absolute humidity. Water vapor can and does diffuse through solid materials. Unlike air infiltration, diffusion can occur without any air leaks whatsoever. Like air infiltration, water vapor diffusing into a building envelope assembly will condense into liquid water if dew point conditions are encountered.



U. S. Climate Zones

It is often said that water vapor moves from warm to cool. Actually, water vapor moves from high absolute humidity to lower absolute humidity. Because warm air usually holds more water vapor than cooler air, water vapor often moves from warm to cool.

Water vapor diffusion can be controlled with the proper application and placement of vapor retarders or by the use of "semi-permeable" materials which allow for "flow-through" design (flow-through designs allow water vapor to diffuse through a building assembly without condensing).

Vapor retarders would normally be installed on the interior side of building assemblies in cold climates and on the exterior side of building assemblies in hot-humid climates. Flow-through designs work well in all climate zones. In Mixed Zones, vapor retarders will tend to be on the "wrong side" of the assembly half the year: flow-through designs in Mixed Zones avoid this problem.

The behavior of thermal and moisture transfer in specific building assembly designs and under specific climate situations can be predicted using WUFI, a computer simulation developed, in part, by Oak Ridge National Laboratory.

Advantages of Spray Polyurethane Foam

Closed-cell spray foam retards both heat transmission and moisture vapor transmission. Because of this, dew point conditions only occur in spray foam when vapor barriers are installed on the cold side ("wrong side") of the foam and moisture can only accumulate when these conditions are held over long periods of time (an example would be a cooler or freezer which has spray foam insulation on the outside with a vapor barrier wall on the inside). For normal building occupancies, daily and seasonal temperature fluctuations avoid moisture condensation and accumulation.

Spray polyurethane foam forms an excellent air barrier, eliminating problems related to air infiltration. Spray polyurethane foam is sprayed on as a liquid, expands in place, and fully adheres to its substrate. In doing so, it fills in small gaps between construction materials and conforms to odd shapes and spaces. House wraps, required with fiber insulations, can be eliminated.

Furthermore, spray foam is moisture tolerant (i.e., spray foam will not rot, corrode, or degrade). If unforeseen leakage or other source of moisture ever occurs to wet the foam, the foam's closed cell structure will prevent water from traveling within the insulation; the foam will perform just as well, once the wetting conditions have been eliminated and the foam has dried out.

Cautions:

1. Open-cell spray foam, while also moisture tolerant, has a much higher permeability than closed-cell spray foam. Because of this, it is more susceptible to moisture accumulation and some constructions may require vapor retarders or venting like conventional insulations. Also, if wetted, water can travel within the open-cell foam.

2. When spray foam is installed in conjunction with a glass fiber batt or other conventional insulation, a vapor retarder may be required.

For these reasons, closed-cell spray polyurethane foam is an ideal material for use with flow-through designed building assemblies, thereby eliminating the need for and the confusion over vapor retarders.

Contact your NCFI applicator for assistance in designing your insulation project.

NCFI polyurethane insulates the space shuttle's fuel tank.

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