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Air Barriers in Biomedical Buildings with HVAC-Induced Differential Pressures Part II

Introduction

In April 2020, DTR published a Technical News Bulletin called "Building Envelope Air Barriers" that gave a brief introduction to the subject of air barrier systems, which are comprised of continuous membranes, sheets, tapes, and fluid-applied coatings. In October 2020, DTR published a second Technical News Bulletin on Air and Water Barrier (AWB) applications in biomedical buildings with HVAC-induced differential pressures. This month's article will delve deeper into how dewpoint is a critical consideration for the designer to ensure proper placement in the system for intended performance.

AWBs work in concert with vapor barriers and insulation systems to control the infiltration/exfiltration of air through the exterior envelope of a building and to ensure that condensation within the wall or roof cross section will not occur during normal temperature and humidity ranges. Good design further ensures that, should condensation occur, provisions exist to drain and dry the condensation plane without causing damage or promoting microbiological growth while mitigating the infiltration of outdoor air with its odors, molds, spores, fungi, bacteria, moisture, heat/cold, etc.

Uncontrolled Moisture in the Building Envelope

There are two sources of uncontrolled moisture in the building envelope:

Externally Generated Moisture: Includes (1) wind-driven moisture entering seams, cracks, and joints between dissimilar materials; (2) vapor diffusion through the exterior cladding materials; (3) infiltration of outdoor moisture-laden air and condensation within the envelope (it is worth noting that infiltration of outdoor air due to air leakage related to HVAC system-induced negative differential pressure is considered an external source, and that warm, moist air has higher vapor pressure than cooler, drier air); and (4) leakage from above via failed flashing, roofing, drains, and ice damming due to gravity, capillary action, surface tension effects, etc. Lower air pressure within the structure can "drive" moisture from the exterior inward until it encounters a surface cool enough to induce condensation.

Internally Generated Moisture: Includes (1) air-diffused moisture generated by building occupants and use of the building, such as respiration, handwashing, cooking, cleaning, etc., in excess of what is removed by the operation of the HVAC system; (2) indoor air leakage that is allowed to enter the building envelope and condense on cool surfaces within the assembly; and (3) leakage from piped utilities which penetrates the building envelope assembly.

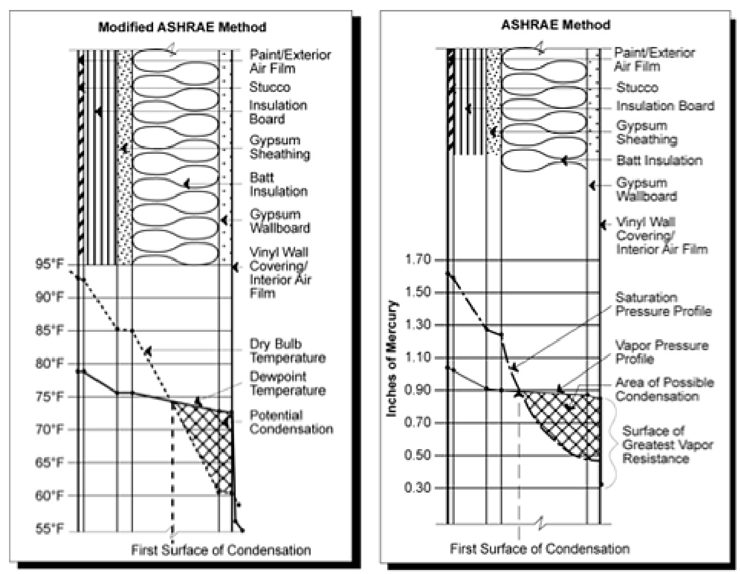
Good design for the management of air and moisture within the building envelope includes:

Weather Barrier: Must include water shedding and control of water penetration capabilities to drain and dry without damage. Should be resistant to blockage of drainage pathways and entry by pests. The expectation is that the material selection, detailing, and installation of this layer be nearly perfect, but this layer must be robust enough to continue to perform as intended despite any failures in execution.

Air and Water Barrier (AWB): The AWB retards air movement and includes water shedding properties (it may serve as the drainage plane behind the weather barrier or as a backup) but must not be classified as a vapor barrier to promote drying. In a warm climate, the AWB is generally located exterior to the primary thermal insulation, while in cold climates it may be positioned beneath the outboard insulation, but to the exterior of the primary thermal insulation. The expectation is that the AWB material selection, detailing, and installation be as good as practicable, especially where exposed to negative pressure from the HVAC system that leaks past the vapor barrier – thus, the AWB and VB are a complementary system.

Vapor Barrier (VB): The VB prevents the diffusion of moisture. In warm climates, the location of the VB should generally be to the exterior of the thermal insulation, and VB material selection, detailing, and installation should be as good as practicable. In cold climates, the VB must occur interior to the thermal insulation, and VB material selection, detailing, and installation should be nearly perfect due to the likelihood of surfaces within the assembly being cold enough to induce condensation (this process should include assessment of interior finishes, especially paints, wallpapers, and wall protection panels which may act as unintended vapor barriers).

Assembly dewpoint analysis is discussed in the ASHRAE Handbook: Fundamentals (Chapter 27; ASHRAE, 2009). It is necessary to complete a version of the ASHRAE Handbook's standard or modified method (see Figure 1) for calculating water vapor diffusion of each major assembly type to ensure these assemblies perform as intended. These methods analyze



(Figure 1 First Surface of Condensation)

each component in an assembly, including their thickness, permeance to vapor transmission, and thermal resistance. Graphs of the temperature profile are developed, progressing from the outdoor to indoor dry bulb and dewpoint temperatures; the intersection of these lines indicates potential saturation and condensation zones within the assembly. Manipulation of the depth and type of insulation are the primary, but not the only, factors in optimizing the section for a given site (climate) and application.

A good design is one where the weather barrier, AWB and VB work as a system in which condensation is only likely to occur in locations where its impact would be benign and where unintended air movement through the wall or roof section is fully mitigated.