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Figure 1: Water will condense on a surface if a mass of air with a given temperature and moisture content reaches a surface with a temperature below dew point.

INHIBITING CONDENSATION

Understanding communication between spaces, environment and people

BY ANDREA BAIRD & SARAH FLOCK

A healthcare facility must serve many functions. Its design must address patient care and provide a conditioned interior separated from the exterior environment, all while maintaining durability and aesthetics. To further complicate matters, the spaces must remain flexible to accommodate expansion, changing technology, remodeling or post-acquisition modifications. However, what often is overlooked during these transitions is the impact of interior changes on the exterior building enclosure.

Healthcare facilities are unique in that one building houses multiple microclimates with different temperatures, relative humidity, air changes and/or pressure relationships. All of these varying conditions can impact the thermal and moisture behavior of the building enclosure.

Interior temperature and relative humidity play important roles in occupant comfort and care. The temperature and relative humidity of healthcare facilities are maintained at higher levels than most other building types. Historically, operating temperatures and relative humidity were controlled to reduce electrostatic discharge, relieve respiratory issues and enhance patient comfort.

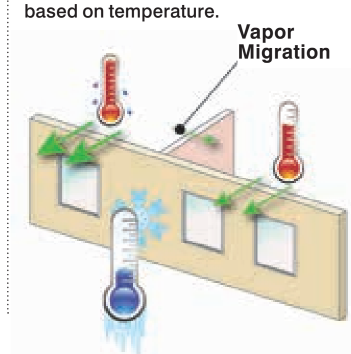
Air temperature, relative humidity are interdependent

When the temperature is reduced, the relative humidity increases with a constant amount of moisture in the air. If a communication path between two spaces exists, air and heat can move due to differential pressure, whereas vapor can migrate due to moving air or as a result of differential vapor pressure. Therefore, design and construction for adjacent rooms and spaces operating under different environmental conditions need special attention.

If a mass of air with a given temperature and moisture content reaches a surface with a temperature below dew point, water will condense on the surface (Figure 1).

With an elevated relative humidity comes a higher dew point and a greater risk of condensation. Since healthcare facilities operate at comparatively high humidity, a cold surface is more likely to be below the dew point. To illustrate, critical and intensive care conditions, as set forth in the ANSI/ASHRAE/ASHE Standard 170-2013 *Ventilation of Healthcare Facilities* (Standard 170), are between 70-75 F and 30-60 percent relative humidity. At 72 F and 30 percent, the dew point is approximately 39 F; however, at 72 F and 40 percent, the dew point is 46 F. Surfaces will fall below 46 F more frequently and under less severe conditions than below 39 F, which creates a greater potential for condensation and moisture accumulation.

Figure 2: Vapor migration based on temperature.



In an effort to reduce issues that may be associated with elevated relative humidity, ASHRAE has recently reduced recommended operating parameters to a 20 percent minimum in some short-term patient care spaces. However, this reduction cannot be used in all spaces, nor is lowering to 20 percent relative humidity enough to prevent condensation in all instances.

Differential interior ambient air conditions create the potential for air and moisture migration, either between spaces or from interior to exterior, as different environments attempt to reach equilibrium (Figure 2).

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Consider condensation potential during design

If condensation potential is overlooked during planning, design or construction, moisture may reach unintended locations with temperatures below the dew point, resulting in potential condensation-related damage, contamination and/or degradation. Condensation potential should be considered during design of new facilities, as well as alterations or renovations.

While cooler temperatures might not have been a concern when a space was storage, offices or short-term patient care areas with low relative humidity, it may become a condensation problem when converted to an intensive care unit or other occupancy spaces with more demanding ambient conditions.

Thermal bridging

Thermal bridging can also reduce temperatures below dew point. The average uninterrupted R-value of the insulation in the building enclosure is often considered when evaluating the thermal efficiency of the assembly. However, conductive materials that bypass or penetrate the insulation plane, such as flashings, metal studs, attachments, etc., provide a path for heat loss and may result in temperatures below the dew point (Figure 3).

Thermal bridging and the effect on temperatures should be carefully considered, especially since adverse effects might be concealed from interior view, and the resulting damage may not be noticed until conditions are extreme. Similarly, components of the building enclosure assembly that are shielded or isolated from interior sources of heat may drop below the dew point. Changing equipment, and/or applying certain finishes or furnishings on the interior face of exterior walls, may inadvertently alter moisture migration and accumulation in the building enclosure and adversely affect performance.

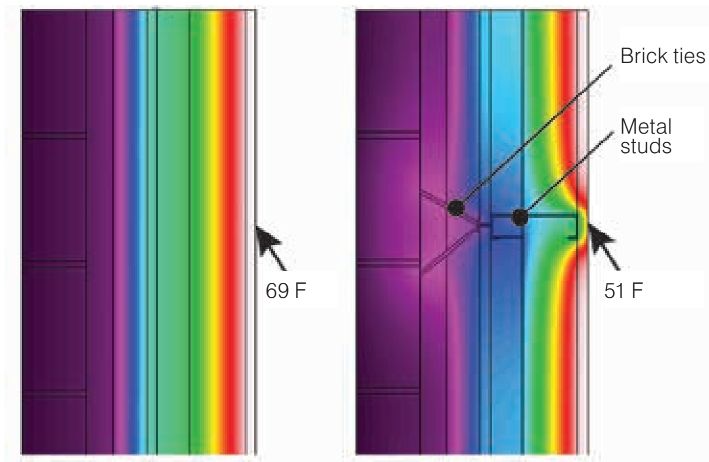
Air leakage

Air leakage between spaces is also an important consideration for both interior and building enclosure performance. Air movement is capable of transporting a much larger mass of moisture than diffusion through materials, resulting in condensation at temperatures below dew point. Pressure differentials, which move air from space to space, can result both from mechanical equipment or temperature differences known as a "stack effect."

Thermal Bridging

Figure 3: Conductive materials that bypass or penetrate the insulation plane, such as flashings, metal studs, attachments, etc., provide a path for heat loss and may result in temperatures below the dew point.

Thermal model of brick wall assembly without thermal bridges | Thermal model of brick wall assembly with thermal bridges



Air Infiltration & Prevention

Figure 4, above: Differential pressures within a building.

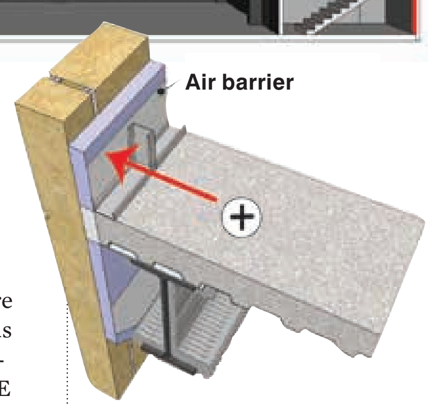


Figure 5: Air barrier between interior spaces.

Air changes and pressure relationships for the various spaces in a healthcare facility are specified in ASHRAE Standard 170. Healthcare facilities need positive pressurization to prevent contaminants from entering (operating rooms) and negative pressure to preclude exfiltration (laboratory). The effect of differential pressure on building performance should be considered as a potential contributor to energy loss and moisture damage. Air moves from high to low pressure to approach equilibrium. If interior spaces at varying air pressures are adjacent and communicate through ducts, gaps, interstitial spaces, cavities or stud spaces, then unintended air transfer between and around spaces can occur.

Moving humidified air can transport a large mass of moisture, potentially distributing moisture from humidified areas to areas with surfaces below the dew point, resulting in condensation. To address this, an air barrier system can be installed. However, since air can move amid internal spaces and between the interior and exterior, buildings should be airtight between all areas of differing environments, including exterior to interior and horizontally and vertically (Figure 4). The pressure differentials will also impact the location of the air barrier within the assembly (Figure 5).

Improving compliance

Monitoring pressure differentials can be tricky in healthcare facilities. Recently, The Joint Commission initiated efforts to improve compliance with pressurization standards since numerous hospitals fail to meet that recommended criterion. It is also vital that owners, designers and constructors communicate and understand existing pressure relationships prior to expansion or retrofit. This information can be used to identify how changes may affect future performance or if additional air control is needed.

Achieving proper enclosure performance requires a clear understanding of the existing and proposed changes to interior environments. Control of pressure, temperature and humidity in healthcare facilities is critical for building envelope performance, patient comfort, infection control and equipment operations. Even minor changes should be evaluated for potential impact, including finish and equipment modifications.

Andrea Baird, NCARB, P.E., LEED AP BD+C, is an architect with Raths, Raths & Johnson. She can be reached at albaird@rrj.com. Sarah Flock, NCARB, is associate and consulting architect with Raths, Raths & Johnson, Inc. She can be reached at skflock@rrj.com.